College education and job-match quality in South Korea

An application of the Gottschalk-Hansen model

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I would like to thank my dearest husband for his utmost support and love. I also want to send my love to my family in South Korea whom I miss a lot.

Summary

In South Korea, 66% of youth aged between 25 and 34 have attained tertiary education in 2012, which is far above the OECD average of 39% (OECD, 2014). The high supply of college graduates leads to substantial competition. According to the Employment Trend for 2014 by Statistics Korea, the unemployment rate for the youth aged between 15 and 29 recorded 9.0%, which is more than double of the overall unemployment rate, 3.5%. The youth unemployment rate in 2014 recorded the highest level since 1999, when a new method for statistics measurement was introduced (Statistics Korea, 2014a).

As well as reducing the high youth unemployment rate, enhancing the job match quality of educated labor force has been an important policy focus of the Korean government. The issue about overly educated labor force and the match quality between education and job has been actively analyzed. However, due to the vague nature of overeducation and job match quality, previous studies rely on the subjective measure of overeducation and job match quality.

Gottschalk and Hansen (2003) provide a fresh look on the issue of overeduaction by introducing a simple model. They define college jobs as the ones that pay significantly high return on college education, while the noncollege jobs are defined as the ones that do not pay significantly high return on college education. This definition of college and non-college jobs has an advantage of being based on market signals such as an employer's willingness to pay a college premium.

This paper applies the approach by Gottschalk and Hansen (2003) in the case of South Korea to ask a slightly different question. It asks how 4 year college education affects job-match quality compared to 2-3 year college education. In South Korea, where the proportion of the people who have a college degree is almost double than the OECD average, this question is as interesting and important as comparing college educated workers to non-college educated workers.

Making use of the Gottschalk and Hansen model, 4 year college jobs are defined as the ones that pay significantly high return on 4 year college education. A worker is defined to be well matched if she holds a job that fits her qualifications. That is, if a 4 year college graduate is

employed in a 4 year college job, her job and education are well matched. In order to focus the analysis on the college graduates, this paper uses the survey data for the college graduates in South Korea, the Graduate Occupational Mobility Survey (GOMS). Using the GOMS, the job match quality of 4 year college graduates is investigated over time.

Our result from log monthly wage regression shows that there is a downward trend in 4 year college premium from 2007 to 2011, which indicates that the relative advantage of 4 year college education compared to 2-3 year college education has been decreasing over time. According to the Gottschalk and Hansen model, a decrease in 4 year college premium would result in more 4 year college graduates distributed in 2-3 year college jobs. That is, the match quality between job and education would be aggravated over time. The match quality between job and education is analyzed more thoroughly by estimating the probability of 4 year college graduates working in 2-3 year college job over time using a logit model. The predicted probability of 4 year college graduates hired in 2-3 year college jobs is found to be increasing over time, which is consistent with the Gottschalk and Hansen model.

Several robustness checks for our analysis are carried out in terms of aggregating occupations, different thresholds to define 4 year college jobs, subgroup analysis, and using a different earning measure. Our analysis is found to be robust to these sensitivity checks. Further analysis regarding labor market outcome of female college graduates are also discussed and shows that female college graduates are not only paid less than male counterparts regardless of the level of education, but the female 4 year college graduate are more likely to experience the mismatch between job and education than the male counterparts.

The GOMS data are available on the Korean Employment Survey Service website (survey.keis.or.kr) and the analysis is mainly carried out using Stata.

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1 Introduction

In South Korea, 66% of youth aged between 25 and 34 have attained tertiary education in 2012, which is far above the OECD average of 39% (OECD, 2014). The high supply of college graduates leads to substantial competition in the labor market. According to the Employment Trend for 2014 by Statistics Korea, the unemployment rate for the youth aged between 15 and 29 recorded 9.0%, which is more than double of the overall unemployment rate, 3.5%. The youth unemployment rate in 2014 recorded the highest level since 1999, when a new method for statistics measurement was introduced (Statistics Korea, 2014a). Facing a harsh job market, a lot of college students postpone graduating from the university for several semesters. They pay part or full tuition fees while preparing themselves with higher English scores, certificates, or more experience such as internships.

Based on the Higher Education Act, the universities that offer academic studies normally provide 4 years of education whereas the ones that offer more vocationally oriented education provide 2-3 years of education. Chae and Oh (2014) point out that two stylized facts in the South Korean labor market, "increasing income gap between college and non-college graduates" and "insignificant income gap between 2-3 year college graduates and non-college graduates" create high demand for entering 4 year colleges. Low social recognition to 2-3 year college in South Korea also attributes to high preference for 4 year college (Chae & Oh, 2014). According to the data by the Korean Educational Statistics Service, about 2 million students were registered in the 4 year universities and 740 thousands students were registered in the 2-3 year colleges in 2014. However, recently there has been a tendency that some 4 year college graduates choose to reenter 2-3 year colleges due to the tough labor market situation (Korean Council for University College Education, 2015). The data by the Statistics Korea (2015) show that the unemployment rate for 4 year college educated youth aged between 20 and 29 recorded 9.3%, which is higher than the one for 2-3 year college educated youth, 7.3% in 2014. Even though the unemployment rate cannot explain the whole picture of the labor market situation, the constantly increasing number of 4 year college graduates who choose to reenter 2-3 year college shows the current labor market crisis that 4 year college graduates are facing.

As well as reducing the high youth unemployment rate, enhancing the job match quality of educated labor force has been an important policy focus of the Korean government. The issue about overly educated labor force and the match quality between education and job has been actively analyzed. However, due to the vague nature of overeducation and job match quality, previous studies rely on subjective measures of overeducation and job match quality. For example, Cho and Lee (2011) examine the relationship between overeducated individuals and their labor market outcomes by using a self-reported measure of the job match quality from survey data. By using a survey question "How do you compare your educational attainment relative to the education level your job requires?", Cho and Lee (2011) find that approximately 25% of the workers report themselves as overeducated. The overeducated workers are estimated to be paid significantly less than the workers who report themselves as adequately educated (Cho & Lee, 2011). However, using the self-assessed measurement of job match quality might ignore other dimensions of individuals' labor market skills. Furthermore, the fact that job match quality is not defined independently from the respondent can induce problems in interpreting results.

Gottschalk and Hansen (2003) provide a fresh look on the issue of overeduaction by introducing a simple model. They define college jobs as the ones that pay significantly high return on college education, while the noncollege jobs are defined as the ones that do not pay significantly high return on college education. This definition of college and non-college jobs has an advantage of being based on market signals such as an employer's willingness to pay a college premium. Gottschalk and Hansen (2003) explore whether college-educated workers have increasingly been employed in noncollege jobs in the US over time. As the college premium increased from 1984 to 1993, the ratio of the college-educated workers employed in the noncollege jobs decreased (Gottschalk & Hansen, 2003).

This paper applies the approach by Gottschalk and Hansen (2003) in the case of South Korea to ask a slightly different question. It asks how 4 year college education affects job-match quality compared to 2-3 year college education. In South Korea, where the proportion of the people who have a college degree is almost double than the OECD average, this question is as interesting and important as comparing college educated workers to non-college educated workers.

Making use of the Gottschalk and Hansen model, 4 year college jobs are defined as the ones that pay significantly high return on 4 year college education. A worker is defined to be well

matched if she holds a job that fits her qualifications. That is, if a 4 year college graduate is employed in a 4 year college job, her job and education are well matched. In order to focus the analysis on the college graduates, this paper uses the survey data for the college graduates in South Korea, the Graduate Occupational Mobility Survey (GOMS). Using the GOMS, the job match quality of 4 year college graduates is investigated over time.

The next section introduces the Gottschalk and Hansen model to explain the theoretical background of the analysis and its application in South Korea. In section 3, detailed information about the GOMS data and the analysis method are described. The results of the analysis are provided in section 4, which includes the classification of occupations and the match quality between occupation and college education over time. The result of several sensitivity checks to our analysis are also presented in section 4. In section 5, the labor market outcome of female college graduates and decreasing 4 year college premium are discussed in detail. The limitations of the analyses are included in section 5. Section 6 presents conclusions of the analysis by revisiting the main findings.

2 Model and application

This section introduces the Gottschalk and Hansen model from their paper in 2003 and provides a way to apply this model to the case of South Korea. More information about the Gottschalk and Hansen model can be found in their paper "Is the proportion of college workers in noncollege jobs increasing?"

There are two sectors in the economy where sector 1 is the college sector and sector 2 is the noncollege sector. Firms belong to either of the two sectors to produce output using both college and noncollge labor forces. Each sector is characterized by the following production functions:

$$Q_1 = F_1(K_1, \varphi_{1c}L_{1c} + \varphi_{1n}L_{1n}) \quad (1)$$

$$Q_2 = F_2(K_2, \varphi_{2c}L_{2c} + \varphi_{2n}L_{2n}) \quad (2)$$

L_{1c} is the number of college workers in sector 1 and L_{2c}denotes the number of college workers in sector 2. L_{1n} and L_{2n} are the number of noncollege workers in sector 1 and 2, respectively. The number of efficiency units embodied in workers in each sector is denoted by φ_{ij}. For example, φ_{1c} denotes the number of efficiency units embodied in college workers in sector 1 and φ_{1n} denotes the number of efficiency units embodied in noncollege workers in sector 1. The college workers are assumed to embody greater efficiency units than the noncollege workers, but college and noncollege workers are assumed to be perfect substitutes.

The fact that sector 1 is the college sector and sector 2 is the noncollege sector implies the difference in productivities of college and noncollege workers are bigger in sector 1 (the college sector) than in sector 2 (the noncollege sector). That is, college workers are relatively more productive than noncollege workers in sector 1 than in sector 2. This can be denoted as $\left(\varphi_{1c}/\varphi_{1n}\right) > \left(\varphi_{2c}/\varphi_{2n}\right)$.

Firms maximize profits ($P_jQ_j - W_{jc}L_{jc} - W_{jn}L_{jn}$) by choosing the number of workers to hire while taking prices as given. According to the first order conditions of the firms, the demand equations for college and noncollege workers are determined as follows.

$$W_{jc} = \varphi_{jc} F_j' \quad (3)$$

$$W_{jn} = \varphi_{jn} F_j' \quad (4)$$

Merging the two demand equations yield the following equation of college premium.

$$\left(W_{jc}/W_{jn}\right) = \left(\varphi_{jc}/\varphi_{jn}\right) \quad (5)$$

According to the assumption of productivity, the college premium in sector 1 is higher than the one in sector 2.

Suppose all college and noncollege workers are employed in one of the two sectors. The number of college and noncollege workers are exogenously given. The labor supply decision of workers are based on the relative wage between the two sectors and their heterogeneous preferences.

$$\ln(L_{1c}) = \gamma_c + \alpha_c \ln(W_{1c}/W_{2c}) \quad (6)$$

$$\ln(L_{1n}) = \gamma_n + \alpha_n \ln(W_{1n}/W_{2n}) \quad (7)$$

where $\gamma_c, \gamma_n > 0$ and α_c and $\alpha_n > 0$.

The equilibrium of the economy is determined by the demand by the firms and the supply by the workers. The demand by the firms depend on the productivity of workers and this consequently determines the sector-specific college premium. The supply by the workers depend on the relative wage across sectors. In the equilibrium some college graduates will be allocated in the noncollege sector given the heterogeneous preference. The relative wage ensures that this allocation is optimal.

When there is a change in productivity, φ_{ji}, the sector-specific college premium changes and this affects the labor supply. For example, when there is a skill-biased technological progress in sector 1, the college graduates will become relatively more productive than noncollege workers. Consequently the increase in φ_{1c} raises the college premium in sector 1. This will move college graduates from sector 2 to sector 1.

This simple framework by Gottschalk and Hansen defines a non-college job as one that offers low college premium. This definition of college and non-college jobs has the advantage of

being based on employer's willingness to pay a college premium. In addition to this simple framework, Gottschalk and Hansen (2004) defines an occupation as a college job when the proportion of the college graduates in the occupation exceeds 90%.

Based on this model, Gottschalk and Hansen (2003) investigate whether skill-biased technological change reduces the proportion of college workers in non-college jobs in the US, using the Current Population Survey (CPS) from 1983-1996. They show that there was an upward trend in college premium and consequently there were fewer college graduates who were employed in non-college occupations in 1994 compared to 1983.

Making use of the model by Gottschalk and Hansen, this paper will compare 4 year college graduates to 2-3 year college graduates instead of college to noncollege workers. 4 year college jobs will be defined as follows: 1) as the job that pays high premium on 4 year college education compared to 2-3 year college education or 2) as the job that contains above 90% of 4 year college graduates and under 10% of 2-3 year college graduates. The occupation is said to be a good match for a 4 year college graduate if the return to a 4 year college degree is relatively high in that specific occupation. Similarly, 2-3 year college graduates are said to be well matched if they find themselves in occupations where the return to a 4 year college graduate is relatively low.

3 Data and method

3.1 Data

The analysis makes use of the Graduates Occupational Mobility Survey (GOMS).[1] The GOMS is a nationally representative survey of young adults in South Korea who graduated from college in a given survey year. The first survey is conducted about 20 months after students' college graduation, considering the job searching period. About 2 years later, the follow up survey is conducted to construct a short-term panel data. The analysis of the paper uses the data from the first round of the survey. All currently available data are used in the analysis, which is the survey data for the graduates in 2005 and from 2007 to 2012. Due to a change in the survey method, the survey for the graduates in 2006 was not conducted. The change leads to differences in some of the survey questions between the data from 2005 and the data from 2007-2012. The analysis adjusts for these differences. The GOMS data give an opportunity to concentrate the analysis on the recent graduates who are entry level in the labor market and have no big distinctions from each other in their labor market experience.

The GOMS contains graduates from three different types of colleges: 4 year college, 2-3 year college, and college of education. Based on the Higher Education Act, the college of education is established to train elementary school teachers. The GOMS from the given periods show that about 98% of the graduates from the college of education have a job as a teacher. Since the purpose of the analysis is to examine the job match quality of college graduates, the graduates from the college of education are excluded from the sample. The sample is limited to the college graduates who were employed at the time of the survey to use their wage as an explanatory variable.[2]

The earning measure of the analysis makes use of the converted monthly wage in Korean Won (KRW) from the GOMS data. The respondents can choose to input the wage in hourly, daily, weekly, monthly and yearly terms. For most of the years, the data offer the converted

[1] The data are available on the Korean Employment Survey Service website (survey.keis.or.kr).
[2] Among the total survey respondents from 2005 to 2012, about 2% were from the college of education and about 22% were not currently working at the time of the survey. These respondents are excluded from our sample.

monthly wage based on the answers from the respondents by converting one year to 12 months and one month to 4.3 weeks. For the respondents who input the wage in daily and hourly terms, the weekly wage is calculated first. For example, the daily income is multiplied by the number of days that the respondent worked in a week to calculate the weekly wage. The wage in an hourly term is multiplied by the sum of normal working hours and over time working hours a week to calculate the weekly wage. The weekly wage is then multiplied by 4.3 to calculate the monthly wage. This conversion method is used to calculate the monthly wage in cases where the converted wage is not provided from the data, which applies to the data for the graduates in 2007, 2011, and 2012.

While respondents' wages in yearly, monthly, and weekly terms are not dependent on the number of hours worked, wages in daily and hourly terms depend on how many hours respondents worked. Even though only less than 2% of the total respondents answered with daily or hourly wage, our results might be sensitive to the earning measure. Therefore, the hourly wage is calculated for the whole respondents, applying the same converting method. For the respondents who input yearly, monthly, weekly, and daily wages, the total number of hours they worked a week is used to calculate the wages they paid in an hourly term.

The converted hourly wage is especially useful to compare the labor market outcomes of the respondents regardless of their type of work, part time or full time, since part time workers are more likely to report their wages in hourly and daily terms than full time workers. This can result from the practicality, since part time workers are more likely to be paid hourly and daily terms than full time workers. While 20% of part time workers answered with hourly and daily wages, less than 1% of full time workers input their wages in hourly or daily term. Therefore, the converted hourly wage is used to check the sensitivity of our analysis in section 3 and 4.

In the sample, both males and females are included, where 44% of the sample are female. About 89% of the sample were aged between 15 and 29 at the time of survey and only 7% were working as a part time worker. Among our sample, 66% are four year college graduates and the rest are 2-3 year college graduates. 21% of the sample graduated from colleges located in Seoul and 87% were single at the time of the survey. Respondents' field of study is divided into 7 different areas and there are overlaps between 2-3 year college graduates and 4 year college graduates in every field of studies.

3.2 Analysis method

The analysis method follows the procedure by Gottschalk and Hansen. The first part of the analysis is to classify the occupations as either 4 year college jobs or 2-3 year college jobs according to the premium that is paid to the 4 year college graduates. The second part of the analysis examines the probability of 4 year college graduates having 2-3 year college jobs in order to evaluate the job match quality over time.

The analysis begins with classifying occupations. The GOMS uses the Korean Employment Classification of Occupation (KECO) from 2007 as a coding method of respondents' job. The paper uses three digit classification of the KECO and aggregates related occupations when it is necessary.

As Gottschalk and Hansen suggests, a job is defined as an occupation when it contains at least 50 4 year college graduates and 50 2-3 year college graduates in order to secure sufficient sample size for estimating 4 year college premium. When an occupation contains less than 50 of each college graduates in the occupation at the original three-digit level, it is aggregated above the three digit level with relevant occupations based on the KECO.

When estimating premium in year t, the data from three consecutive years (t-1, t, and t+1) are pooled in order to obtain a sufficiently large sample. Due to the change of survey method, there is a discontinuation in data collection in 2006. Therefore, in order to estimate 4 year college premium for graduates in 2007, the data from 2005, 2007, and 2008 are pooled. Since the currently available GOMS data are for the graduates in 2005 and from 2007 to 2012, the college premium is estimated for five years, from 2007 to 2011. The occupation aggregation method is based on the sample from the first three years and this method is applied for other years. 68 occupations are defined in consequence of aggregation. The list of defined occupations can be found in Appendix Table 1.

The following regression equation is run to estimate the 4 year college premium for every year and every occupation.

$$ln\, W_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 4yearcollege_{it} + \varepsilon_{it} \quad (8)$$

W_{it} denotes the converted monthly wage of individual i in year t, X_{it} includes year dummies and all the personal characteristics of individual i in year t that can affect the log monthly

wage. 4yearcollege_{it} is a dummy variable that equals to 1 when the respondent i in year t has 4 year college education and equals to 0 when the respondent has 2-3 year college education, and ε_{it} denotes an error term.

The personal characteristics include the gender of the respondent, the age of the respondent (included in linear and quadratic terms), the type of the current job (part-time or full-time), the marital status of the respondent (single or married), respondent's average grade from college, language training experience abroad, whether the respondent has a certificate, the income and education level of parents, whether the respondent currently lives in the city, respondent's field of the study, and whether the respondent graduated from a college located in Seoul. The last explanatory variable reflects the common social recognition in South Korea that the colleges located in Seoul are often classified as good colleges. A more detailed explanation of the control variables can be found in Appendix Table 2.

An occupation is classified as either 4 year college job or 2-3 college job according to the result of regression on each year and each occupation. Before proceeding to the classification, the regression on aggregated occupations for each year from 2005 to 2012 is run first to check the validity of control variables. A dummy variable for studying medical sciences is excluded from the regression due to multicollinearity issue. The regression results are presented in Table 1.

From every year, the following variables are estimated to have positive and significant effects on log monthly wage: 4 year college education, age, graduating from a college located in Seoul, high GPA, going abroad for language training, and higher family income. On the other hand, the following variables are estimated to have a significantly negative effect on log monthly wage: female, age squared term, having a part-time job instead of full-time job, and being single instead of being married. Furthermore, compared to studying medical sciences at college, majoring in other fields of study is estimated to have a significant and negative effect on log monthly earning. The other control variables, such as having a certificate, education level of both parents, and residing in city, show mixed results every year. The difference in the sample sizes across the year comes from the difference in the number of excluded samples, unemployed or graduates from college of education.

Table 1. – Log Monthly Wage Regression by Year

	(1) 2005	(2) 2007	(3) 2008	(4) 2009	(5) 2010	(6) 2011	(7) 2012
4 year college education	0.103*** (0.006)	0.107*** (0.008)	0.074*** (0.010)	0.110*** (0.009)	0.056*** (0.009)	0.066*** (0.009)	0.026** (0.011)
Female	-0.154*** (0.008)	-0.173*** (0.009)	-0.159*** (0.011)	-0.193*** (0.010)	-0.168*** (0.010)	-0.187*** (0.010)	-0.138*** (0.012)
Age	0.075*** (0.006)	0.057*** (0.007)	0.083*** (0.010)	0.034*** (0.009)	0.068*** (0.008)	0.064*** (0.008)	0.071*** (0.010)
Age^2	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.000** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
Part time	-0.793*** (0.017)	-0.669*** (0.021)	-0.615*** (0.020)	-0.789*** (0.031)	-0.820*** (0.025)	-0.914*** (0.024)	-0.660*** (0.026)
College in Seoul	0.139*** (0.007)	0.134*** (0.009)	0.136*** (0.010)	0.152*** (0.010)	0.149*** (0.010)	0.171*** (0.010)	0.108*** (0.012)
Single	-0.107*** (0.010)	-0.092*** (0.013)	-0.102*** (0.015)	-0.116*** (0.015)	-0.078*** (0.016)	-0.093*** (0.016)	-0.034* (0.020)
GPA	0.029*** (0.004)	0.044*** (0.009)	0.025** (0.010)	0.038*** (0.010)	0.022** (0.010)	0.031*** (0.010)	0.031*** (0.010)
Language	0.105*** (0.009)	0.100*** (0.010)	0.106*** (0.010)	0.097*** (0.010)	0.123*** (0.010)	0.114*** (0.010)	0.097*** (0.013)
Certificate	0.005 (0.006)	0.023*** (0.008)	0.044*** (0.009)	-0.014* (0.008)	0.055*** (0.010)	0.015* (0.009)	0.037*** (0.009)
Dad no college	-0.001 (0.008)	-0.010 (0.010)	-0.011 (0.011)	-0.036*** (0.010)	-0.019* (0.011)	-0.028*** (0.010)	-0.018 (0.012)
Mom no college	-0.031** (0.012)	-0.030** (0.013)	-0.015 (0.014)	-0.020 (0.014)	0.026* (0.014)	0.015 (0.013)	0.001 (0.016)
Family income	0.061*** (0.002)	0.054*** (0.002)	0.017*** (0.003)	0.018*** (0.003)	0.017*** (0.003)	0.012*** (0.003)	0.022*** (0.003)
City	-0.020*** (0.006)	0.003 (0.007)	0.014* (0.008)	-0.003 (0.007)	-0.036*** (0.008)	0.008 (0.008)	-0.000 (0.009)
Humanities	-0.234*** (0.014)	-0.232*** (0.016)	-0.240*** (0.018)	-0.250*** (0.018)	-0.260*** (0.019)	-0.242*** (0.018)	-0.215*** (0.020)
Social sciences	-0.136*** (0.011)	-0.154*** (0.014)	-0.146*** (0.016)	-0.164*** (0.014)	-0.169*** (0.014)	-0.152*** (0.014)	-0.115*** (0.016)
Education	-0.155*** (0.015)	-0.211*** (0.018)	-0.220*** (0.020)	-0.189*** (0.018)	-0.186*** (0.019)	-0.224*** (0.019)	-0.175*** (0.023)
Engineering	-0.094*** (0.011)	-0.096*** (0.013)	-0.096*** (0.015)	-0.102*** (0.014)	-0.116*** (0.015)	-0.116*** (0.015)	-0.074*** (0.017)

Natural sciences	-0.187*** (0.013)	-0.188*** (0.016)	-0.194*** (0.017)	-0.184*** (0.016)	-0.222*** (0.017)	-0.215*** (0.018)	-0.198*** (0.020)
Arts, music, and physical education	-0.216*** (0.014)	-0.260*** (0.016)	-0.318*** (0.018)	-0.294*** (0.017)	-0.285*** (0.017)	-0.296*** (0.018)	-0.274*** (0.019)
Constant	3.559*** (0.099)	3.943*** (0.120)	3.676*** (0.168)	4.560*** (0.155)	3.994*** (0.144)	4.154*** (0.135)	3.883*** (0.174)
Observations	20,318	13,068	13,195	11,383	13,238	13,560	10,370
R-squared	0.433	0.374	0.299	0.307	0.288	0.316	0.262

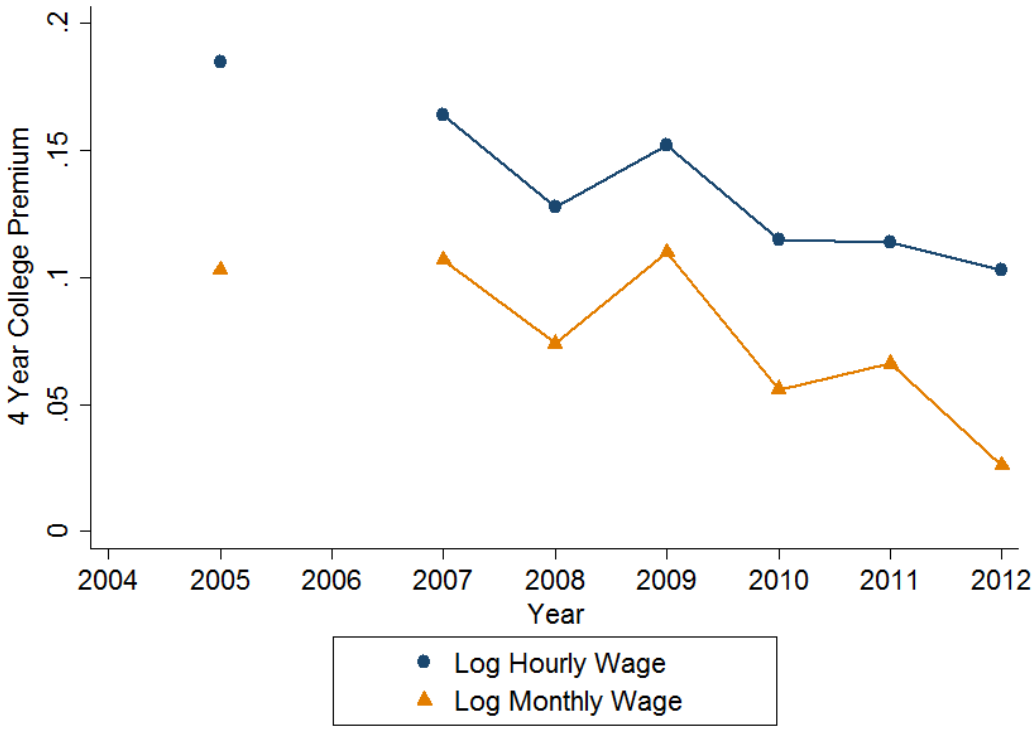
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The same regression on log hourly wage shows very similar results, except that the 4 year college premium on log hourly wage is estimated to be higher than on log monthly wage. The regression result on log hourly wage is reported in Appendix Table 3. Regardless of which wage unit is used as a dependent variable, working part time job is estimated to have a significantly negative effect on earnings in most of the years. Since the results from our log wage regressions are found to be robust to the earning measure, the converted monthly wage is used in the main analyses. The hourly wage is used in the section 4 where more sensitivity checks are carried out.

Figure 1 represents estimated 4 year college premiums on log monthly and hourly wage in 2005 and between 2007 and 2012, which shows a downward trend over time. This outcome contradicts the results from Gottschalk and Hansen (2003), where the college premium shows a steady upward trend from 1982 to 1995 in the US Grazier et al. (2008) apply the Gottschalk and Hansen model in case of the UK and show that college premium has an upward trend from 1994 to 1999 and from 2002 to 2004.

The downward trend in 4 year college premium indicates that the relative advantage of 4 year college education compared to 2-3 year college education has been decreasing over time. Decreasing 4 year college premium is discussed in more detail later in section 5, since the downward trend in 4 year college premium drives the result of the analysis.

Figure 1. – Trend in 4 Year College Premium



According to the Gottschalk and Hansen model, a decrease in 4 year college premium would result in more 4 year college graduates distributed in 2-3 year college jobs. That is, the match quality between job and education would be aggravated over time. The match quality over time is examined in the next section and we first begin by classifying an occupation as either a 4 year college job or a 2-3 year college job.

4 Results

4.1 Classification of occupations

The regression is run for each occupation and each year to classify occupations as either 4 year college jobs or 2-3 year college jobs. According to the output from the regression, an occupation is classified as 4 year college job: 1) when a coefficient of 4 year college education is above 0.1 and statistically significant, or 2) when above 90% of employees are 4 year college graduates. In the same way, an occupation is defined as 2-3 year college job: 1) when the coefficient of 4 year college degree is under 0.1 or it is statistically insignificant, or 2) when above 90% of employees are 2-3 year college graduates.

Appendix Table 4 contains the following information in each occupation in 2007 and 2011: estimated coefficient of 4 year college education and its statistical significance, the percentage of 4 year college graduates working in the occupation, average monthly wage, and average monthly wage for 4 year college graduates. The occupations are listed according to the size of the estimated 4 year college premium in 2007 from the smallest to the largest.

Occupations that can be commonly viewed as 4 year college jobs are estimated to offer high premium for 4 year college education. For example, doctors and medical and welfare service related workers are paid one of the highest 4 year college premiums in both 2007 and 2011 even after controlling for the field of study. There are two occupations that are estimated to pay significantly negative premium to 4 year college education: an occupation including secretaries and assistant clerks and an occupation containing professors, teaching assistants, education related professionals, and teachers. The latter occupation related to education is classified as 4 year college job since the proportion of the 4 year college graduates in the occupation is 96.5%, which exceeds the threshold 90%. The other occupation containing secretaries and assistant clerks do not normally require 4 year college education.

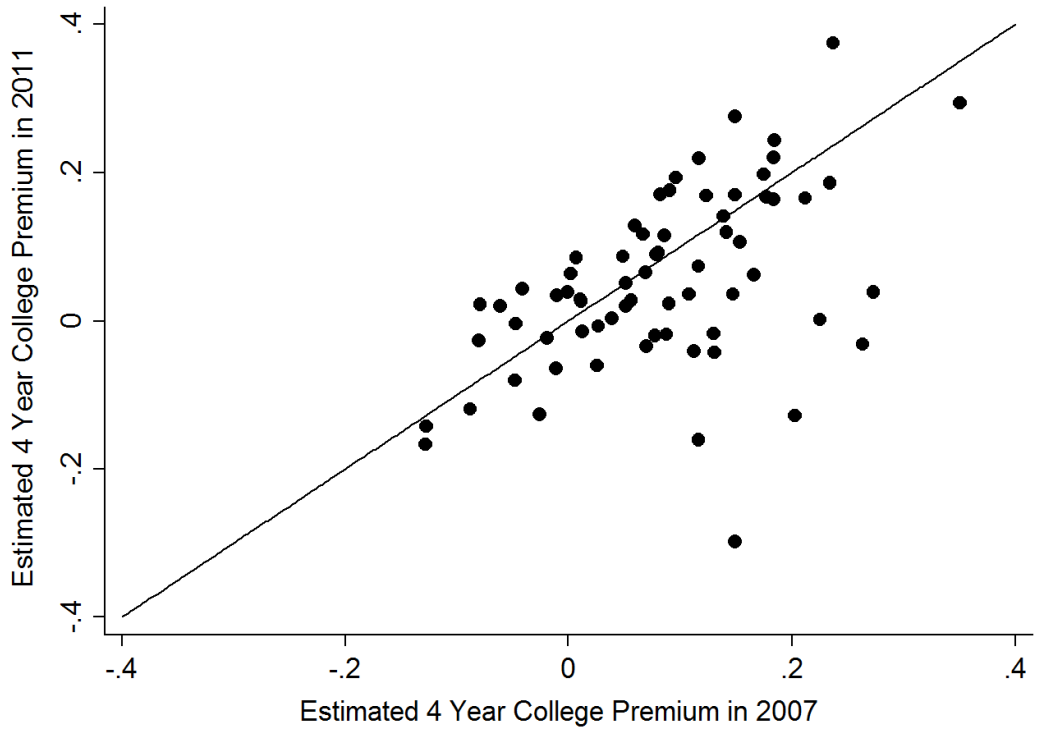
The 4 year college premium and the average wages for 4 year college graduates are positively correlated (0.495) in 2007. However, there are occupations that offer relatively high average wages for 4 year college graduates and low premium, such as police, fire fight and prison related workers. On the other hand, there are occupations that offer relatively low average

wage for 4 year college graduates and high premium, such as an occupation including professors and teaching assistants. Therefore, the 4 year college premium and the average wage for 4 year college graduates are positively, but weakly correlated.

If there is a systematic relationship between the level of aggregating occupations and 4 year college premium, it can be an issue. However, Appendix Table 4 shows that aggregated occupations are spread over occupations that offer different level of premiums. The average of 4 year college premiums is higher in aggregated occupations, 0.098, than the one in non-aggregated occupations, 0.074, in 2007. Later in the same section, it is shown that the aggregation of occupations does not drive the result concerning the match quality between job and education over time.

Figure 2 represents a scatter plot of estimated 4 year college premium in each occupation from 2007 and 2011. Each point represents the estimated 4 year college premium in a specific occupation in 2007 and 2011. The number of occupations located below the 45 degree line is larger than the number of occupations located above the line, which indicates that the number of occupations with diminished 4 year college premium is larger than the number of occupation with increased 4 year college premium over time.

Figure 2. – Scatter Plot of 4 Year College Premium in 2007 and 2011



4.2 Match quality over time

From 2007 to 2011, the number of 4 year college jobs decreased from 24 to 20 and the average 4 year college premium decreased from 0.083 to 0.052. The proportion of 4 year college graduates employed in 4 year job decreased from 42% to 32% over time. Figure 3 displays kernel density estimates of 4 year college premiums in 2007 and 2011 for our sample of 4 year college graduates, where each 4 year college graduate is assigned to the 4 year college premium in their occupations.

Figure 3. – Kernel Density Estimates of 4 Year College Premiums in 2007 and 2011

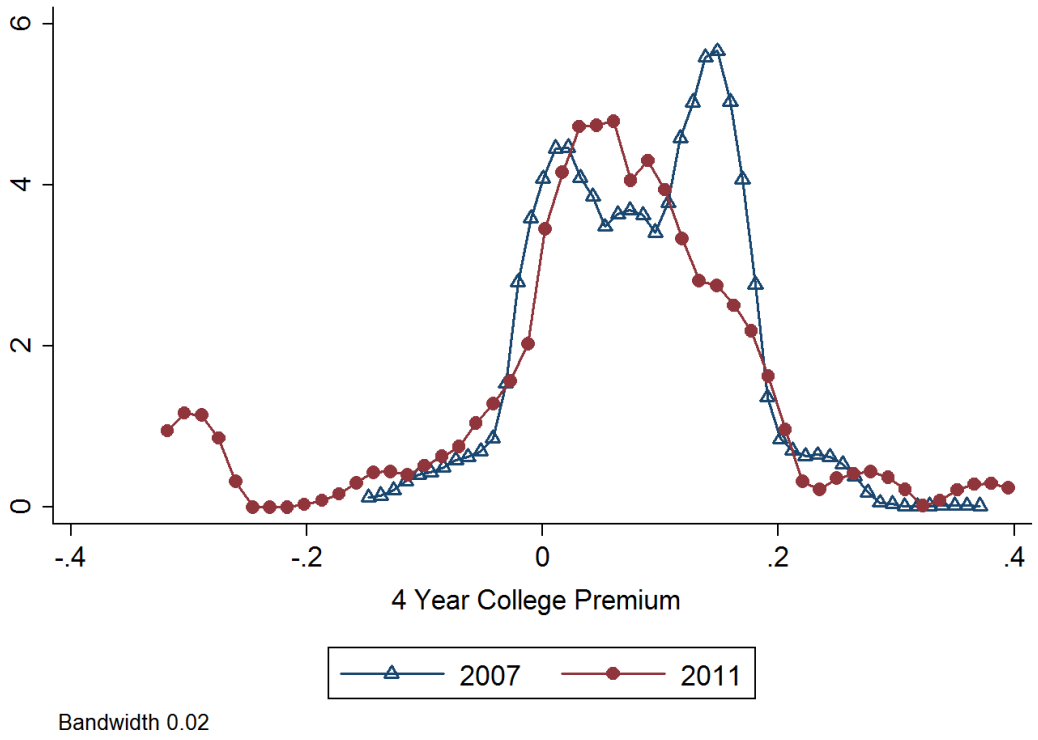


Figure 3 shows that 4 year college graduates are distributed in occupations that offer different college premiums in both years. In 2011, 4 year college graduates are more widely distributed in occupations that offer different premiums than in 2007. From 2007 to 2011, the density distribution slightly shifts from right to the left, which is consistent with the result from Figure 1 that shows a downward trend in 4 year college premium over time. According to the Gottschalk and Hansen model, the decrease in 4 year college premium leads to aggravated match quality between job and education over time.

This is analyzed more thoroughly by estimating the probability of 4 year college graduates working in 2-3 year college job over time using a logit model. The sample is limited to 4 year

college graduates. The following equation specifies the logit model, which includes a dummy variable for gender, the annual overall unemployment rate,[3] and time in linear and quadratic terms as control variables.

$$Prob_{it}(\mathrm{Y}=1) = \lambda_0 + \lambda_1 Time_{it} + \lambda_2 Time_{it}^2 + \lambda_3 Female_{it} + \lambda_4 Unemp_{it} + \varepsilon_{it} \quad (9)$$

Y equals to 1 when 4 year college graduate is employed in 2-3 year college job, where the coefficient of 4 year college education is estimated to be less than 0.1 or not significant. Time specifies a deviation of the given year from 2006. The quadratic time term is included to verify time trend. Gottschalk and Hansen (2003) also include a dummy variable for ethnic group in the equation, but here only the dummy variable for female is included.[4]

The first and second column in Table 2 represent the result of the logit model. The marginal effects estimated at the sample average. The estimated marginal effect of the unemployment rate is negative, which indicates that 4 year college graduates are less likely to be employed in 2-3 year college jobs when the unemployment rate is high. This indicates that the overall annual unemployment rate may not be a good indicator of unemployment rate for our sample. The sample is limited to 4 year college graduates and about 93% of the sample aged between 15 and 29 at the time of the survey. While Gottschalk and Hansen (2003) use the gender adjusted unemployment rate in the logit model, Grazier et al. (2003) find using the gender adjusted unemployment rate in the analysis gives the counter-intuitive result where the coefficient of the gender adjusted unemployment rate is estimated to be negative.[5] Therefore, the overall unemployment rate is replaced with the GDP growth rate in the given year and the result is presented in column 3 and 4 in Table 2.

Table 2 shows that the sign and the marginal effect of the GDP growth rate is estimated to be positive. This indicates that there are more 4 year college graduates employed in 2-3 year college jobs when the GPD growth rate is higher, which is also counter-intuitive. However, the result shows trivial difference in the estimated marginal effects of other variables compared to the logit model result using the overall unemployment rate. When the logit model is run with another alternative variable, the youth unemployment rate in the given year,

[3] The annual unemployment rate is available on the Statistics Korea website (www.index.go.kr).
[4] There is no information regarding ethnicity of respondents in the GOMS and furthermore, almost all of inhabitants in South Korea has Korean ethnicity.
[5] Grazier et al. (2008) use gender and age adjusted unemployment rate in the logit model instead of gender adjusted unemployment rate.

the marginal effect of the time variable is estimated to be positive. The logit model without any alternative for the overall unemployment rate also shows similar results in terms of sign and marginal effects of other variables. Therefore, using different indicators for labor market situation leads to no difference in our main result. The fact that there have been low fluctuations in the unemployment rates during the given period can also attribute to the result in Table 2.[6] The most appropriate labor market indicator for our sample would be using the employment rate of 4 year college graduates in the given year produced by Statistics Korea and Korean Educational Development Institute. However, due to a change in the measurement method in 2010, the statistics before and after 2010 are not comparable.

Table 2. – Logit Estimates of Probability: A 4 Year College Graduate Is Employed in a 2-3 Year College Job from 2007 to 2011

	Unemployemnt Rate		GDP Gowth Rate	
	(1) Coefficient	(2) Marginal effect	(3) Coefficient	(4) Marginal effect
(Year – 2006)	0.198***	0.036	0.185***	0.026
	(0.052)	(0.002)	(0.040)	(0.002)
$(Year – 2006)^2$	-0.007		-0.012*	
	(0.008)		(0.007)	
Female	0.698***	0.161	0.695***	0.160
	(0.020)	(0.005)	(0.020)	(0.005)
Unemployment Rate	-0.486***	-0.112		
	(0.082)	(0.018)		
GDP Growth Rate			0.065***	0.015
			(0.006)	(0.001)
Constant	1.408***		-0.406***	
	(0.226)		(0.063)	
Observations	46,793		46,793	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[6] The overall unemployment rate recorded 3.2%, 3.2%, 3.6%, 3.7%, and 3.4% from 2007 to 2011, respectively (Statistics Korea, 2014b).

The estimated coefficient of Female is significantly positive in both logit analyses, which indicates that female 4 year college graduates are more likely to be distributed in 2-3 year college jobs than the male counterparts. That is, the match quality of female 4 year college graduates is worse than the one of male 4 year college graduates.

The estimated coefficient of Time is statistically significant and positive reassuring that the match quality for 4 year college graduates has been aggravated over time. The coefficient of the quadratic Time term is estimated to be statistically insignificant from the result using the unemployment rate. The result with GDP growth rate shows that the coefficient of the quadratic Time is estimated to be negative and statistically significant, indicating 4 year college graduates are more likely to be employed in the 2-3 year college jobs, but the trend has weakened over time.

Figure 4 represents the estimated probability of 4 year college graduates employed in 2-3 year college jobs using the results from column 1 and 2 in Table 2. The probability is predicted at the sample means. Since the estimated marginal effects of time related variables and female show trivial differences, the predicted probabilities from both logit models show very similar graphs. Only the result using the overall unemployment rate is reported.

Figure 4. – Estimated Probability of Mismatch between Job and Education

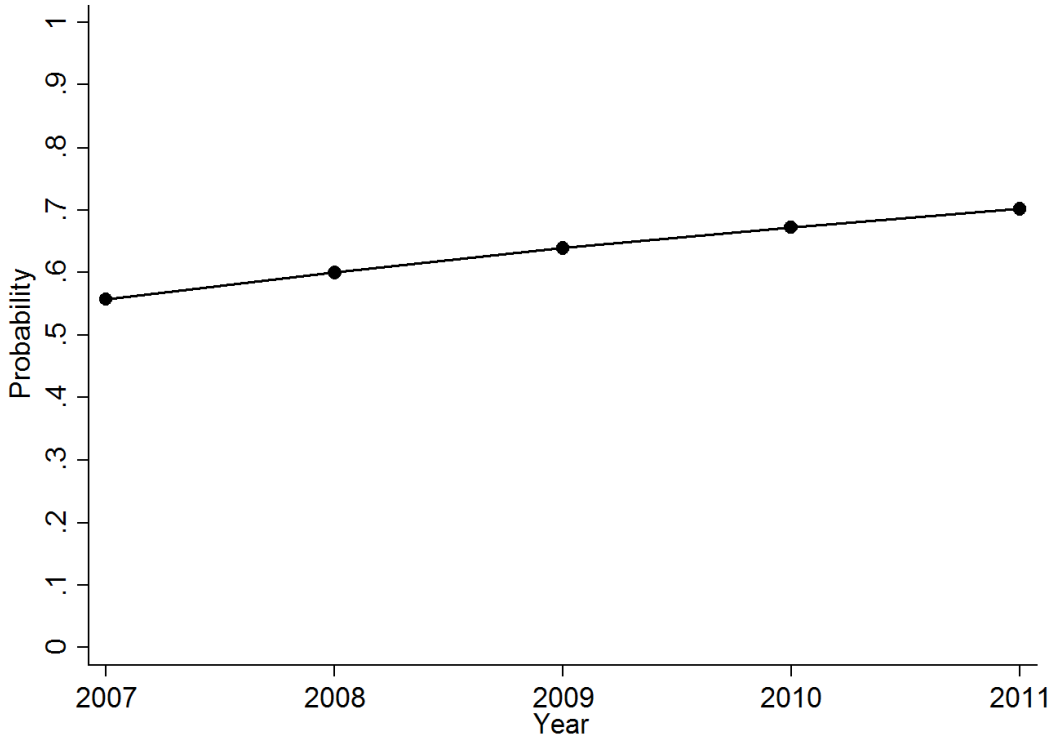


Figure 4 graphically shows that there are slightly more 4 year college graduates employed in 2-3 year college jobs in 2011 than in 2007. This result is consistent with the Gottschalk and Hansen model, where the decrease in 4 year college premium would induce more 4 year college graduates employed in 2-3 year college jobs. However, the result of applying the Gottschalk and Hansen model in South Korea is the opposite of the results from the paper by Gottschalk and Hansen (2003) using the US data and Grazier et al. (2008) using the UK data. The difference stems from the trend in 4 year college premium (college premium in case of Gottschalk and Hansen), which shows an opposite trend. While the trend in 4 year college premium in South Korea is estimated to be diminishing over time, the college premiums in the UK and the US data show an upward trend according to Gottschalk and Hansen (2003) and Grazier et al (2008). The downward trend in 4 year college premium is discussed in detail in terms of wide variations in 4 year colleges and the economic recession in South Korea in section 5.

4.3 Sensitivity of results

To check if the result is driven by specifications of the model, several sensitivity checks are carried out in this section. The first sensitivity check is related to the aggregation of occupations. Several occupations are aggregated above the original three digit level by the KECO to secure enough number of 4 year college graduates and 2-3 year college graduates in each occupation. In order to check whether the aggregation drives the result, a dummy variable for aggregated occupations is included in the logit model. The dummy variable equals to one when the occupation is aggregated with others and zero otherwise. The result of the logit model including the dummy variable is presented in Table 3.

Table 3. – Logit Model with a Dummy Variable for Aggregation

	(1) Coefficient	(2) Marginal effect
(Year – 2006)	0.200*** (0.052)	0.036 (0.002)
$(Year - 2006)^2$	-0.007 (0.008)	
Female	0.693*** (0.020)	0.160 (0.005)
Unemployment Rate	-0.482*** (0.082)	-0.111 (0.019)
Aggregation	0.343*** (0.022)	0.079 (0.005)
Constant	1.303*** (0.227)	
Observations	46,793	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Even though the coefficient of aggregating job is estimated to be significant and positive, including the dummy variable for aggregating job has trivial effects on the sign and marginal effect of other variables. The estimated probability of a 4 year college graduate employed in a

2-3 year college job using the result from Table 3 shows very similar result with Figure 4, which verifies that the match quality over time is not driven by occupation aggregation.

Secondly, in order to check whether a certain threshold used to distinguish 4 year college jobs from 2-3 year college jobs drives the result, the logit models using 0.08 and 0.15 as the threshold instead of 0.1 are estimated. The two alternatives are chosen because the kernel distribution in Figure 3 shows bi-modal distribution and it peaks below and above 0.1. The estimated coefficients and the marginal effects at the sample mean from the logit model are presented in Table 4.

Table 4. – Logit Model with Different Thresholds

	Threshold: 0.08		Threshold: 0.15	
	(1) Coefficient	(2) Margianl effect	(3) Coefficient	(4) Marginal effect
(Year – 2006)	0.219***	0.051	1.203***	0.018
	(0.050)	(0.002)	(0.064)	(0.001)
$(Year – 2006)^2$	-0.002		-0.173***	
	(0.008)		(0.010)	
Female	0.451***	0.112	0.630***	0.068
	(0.019)	(0.005)	(0.026)	(0.003)
Unemployment	-0.307***	-0.076	-0.583***	-0.063
	(0.079)	(0.019)	(0.107)	(0.011)
Constant	0.434**		1.635***	
	(0.218)		(0.299)	
Observations	46,793		46,793	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Different thresholds change the definition of 4 year college jobs. When 0.1 is used as the threshold, 4 year college jobs are defined as the ones that pay 10% higher wage to 4 year college education compared to 2-3 year college education. Using 0.08 and 0.15 as the thresholds changes the definition of 4 year college jobs as the ones pay 8% and 15% higher wage to 4 year college education compared to 2-3 year college education, respectively.

Increasing the threshold reduces the number of 4 year college jobs and proportion of 4 year college graduates employed in 4 year college jobs in every year. Decreasing the threshold to 0.08 from 0.1 leads to the opposite result. Table 4 shows that there is no change in sign of the Time variable and its marginal effect when different thresholds are used. This result shows that a certain threshold does not drive the results of the match quality between job and education.

The fields of study are divided into seven different areas. The log monthly earning regression from Table 1 shows that different fields of study have significant effects on earnings. In order to examine whether certain fields of study drive our result, the logit model including dummy variables for fields of study is analyzed. The result is reported in Table 5.[7]

Table 5. – Logit Model with Field of Study Dummies

	(1) Coefficient	(2) Marginal effect
(Year – 2006)	0.286***	0.041
	(0.055)	(0.002)
(Year – 2006)^2	-0.018**	
	(0.008)	
Female	0.390***	0.088
	(0.023)	(0.005)
Unemployment Rate	-0.661***	-0.149
	(0.087)	(0.019)
Humanities	2.014***	0.455
	(0.056)	(0.013)
Social sciences	2.187***	0.494
	(0.052)	(0.012)
Education	2.114***	0.478
	(0.065)	(0.015)
Engineering	0.529***	0.120
	(0.052)	(0.012)
Natural sciences	1.731***	0.391
	(0.055)	(0.013)
Arts, music and	2.048***	0.463
physical education	(0.058)	(0.013)
Constant	0.496**	
	(0.246)	
Observations	46,793	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[7] The dummy variable for studying medical sciences is excluded due to multicollinearity issue.

All dummy variables for the fields of study are estimated to be significant and positive, indicating that compared to 4 year college graduates from medical studies, 4 year college graduates from all the other fields of study are more likely to be employed in 2-3 year college jobs. However, estimated coefficient and the marginal effect of other variables predict aggravated match quality of education and job over time. Therefore, our results do not change when the additional control variables of study fields are included.

In order to check whether several subsamples drive the result, the logit model on limited samples is analyzed. First, the logit model for the samples who graduated from the college located inside and outside of Seoul are analyzed separately. The results are presented in Table 6, where the first two columns represent the result of the graduates from colleges located in Seoul and the last two columns report the result of the graduates from colleges located outside of Seoul.

Table 6. – Logit Model by College Inside/Outside of Seoul

	College in Seoul		College ouside of Seoul	
	(1) Coefficient	(2) Marginal effect	(3) Coefficient	(4) Marginal effect
(Year – 2006)	0.006	0.042	0.263***	0.034
	(0.101)	(0.004)	(0.060)	(0.003)
$(Year – 2006)^2$	0.029*		-0.019**	
	(0.015)		(0.009)	
Female	0.542***	0.128	0.763***	0.174
	(0.038)	(0.009)	(0.024)	(0.006)
Unemployment Rate	-0.624***	-0.147	-0.427***	-0.098
	(0.160)	(0.037)	(0.095)	(0.021)
Constant	2.081***		1.142***	
	(0.442)		(0.264)	
Observations	12,406		34,387	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results of the two subsamples are found to be very similar to each other and to the results from Table 2. The predicted probability of 4 year college graduates being hired in 2-3 year college jobs for the both subgroups are reported in Figure 5. The predicted probabilities are very close to each other, except that the shapes of the graph are different due to the estimated sign of the quadratic Time term.

Figure 5. – Estimated Probability by College Inside and Outside of Seoul

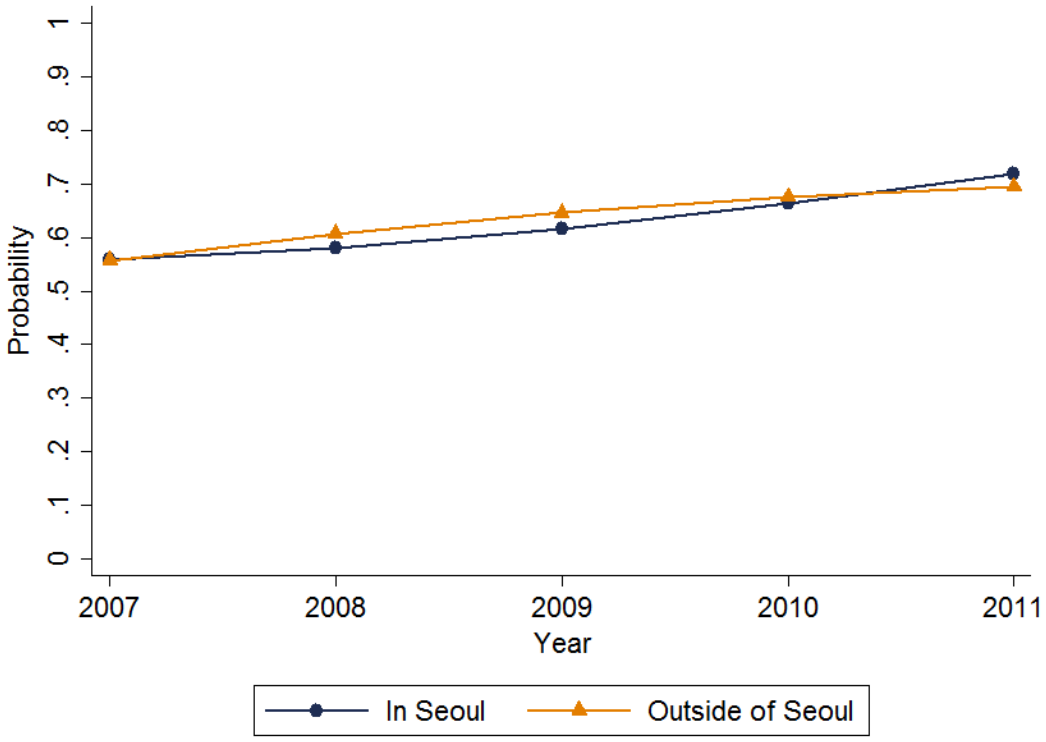


Table 7 presents the result of the logit model for part time workers and full time workers separately. The result of part time workers is reported in the first and second columns and the result of full time workers is presented in the third and fourth columns in Table 7. The marginal effects are estimated at the sample mean.

The estimated marginal effect of Time remains positive in both cases, which indicates the job match quality is aggravated for both part time and full time workers over time. However, the estimated marginal effect of the Time variable is much larger for part time workers than full time workers.

Table 7. – Logit for Part time/ Full time workers

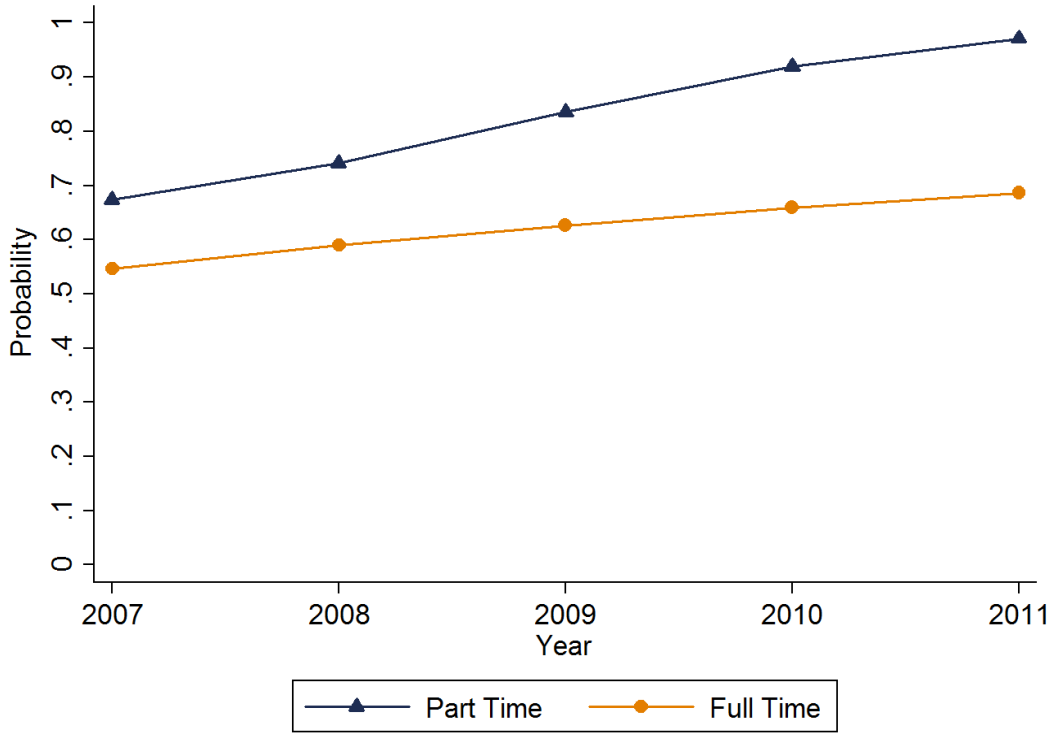
	Part time workers only		Full time workers only	
	(1) Coefficient	(2) Marignal effect	(3) Coefficient	(4) Marginal effect
(Year – 2006)	-0.047	0.097	0.204***	0.035
	(0.252)	(0.010)	(0.054)	(0.002)
$(Year – 2006)^2$	0.124***		-0.009	
	(0.041)		(0.008)	
Female	0.185*	0.029	0.699***	0.163
	(0.101)	(0.016)	(0.021)	(0.005)
Unemployment Rate	-5.536***	-0.868	-0.251***	-0.059
	(0.449)	(0.058)	(0.084)	(0.019)
Constant	19.164***		0.565**	
	(1.299)		(0.233)	
Observations	2,926		43,849	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The predicted probabilities of 4 year college graduates employed in 2-3 year jobs from both subsamples are reported in Figure 6. The possibility of part time workers being employed in 2-3 year college jobs is always higher and increases more sharply than the one of full time workers.

From Table 1, where the results from log wage regressions are presented, working part time is estimated to have a negative effect on wage. This suggests that the 4 year college graduates working part time are not only paid less, but also more likely to be mismatched over time compared to the ones working full time. This can stem from the fact that the part time job is explained as "a temporary job to earn money" in the survey questionnaire from 2008. Since the graduates consider a part time job as a temporary job, they would mind less about lower payment and match quality. For the purpose of our analysis, it could be more appropriate to use only full time workers, but the results of logit model of full time workers and the whole sample show only minimal differences.

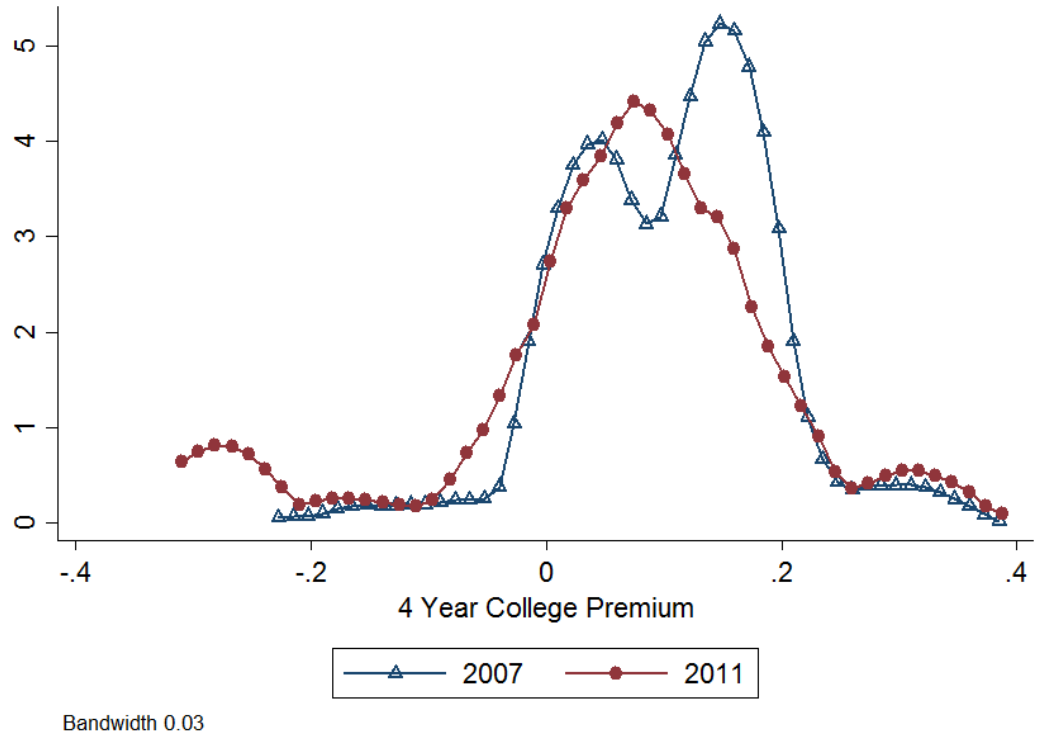
Figure 6. – Estimated Probability by Type of Work (Part/Full Time)



To check if our analysis on match quality is sensitive to the earning measure, the analysis using the converted hourly wage instead of the converted monthly wage is carried out. The same analysis procedure is repeated. The 4 year college occupations are defined as the ones that offer high premium to 4 year college graduates. The same log wage regression is run in each occupation and every year by changing the dependent variable to the converted hourly wage from the converted monthly wage. If the estimated coefficient of 4 year college education in a certain occupation is higher than 0.1 and statistically significant, this occupation is classified as a 4 year college job.

The number of 4 year college jobs decreased from 28 to 22 and the average 4 year college premium is decreased from 0.108 to 0.078 from 2007 to 2011. The proportion of 4 year college graduates employed in 4 year jobs decreased from 50% to 41% over time. Figure 7 displays kernel density estimates of 4 year college premiums in 2007 and 2011 for our sample of 4 year college graduates. Each 4 year college graduate is assigned to the 4 year college premium in their occupations based on the log wage regression results on the converted hourly wage. Figure 7 is very similar to the kernel density estimates from Figure 3 as the density estimates shifts slightly from right to left over time.

Figure 7. – Kernel Density of 4 Year College Premiums from the Hourly Wage



In order to explore the match quality over time, the same logit model specified in equation 9 is run by using the job classifications from the log hourly wage regression. The result from the logit model is presented in Table 8 and the marginal effects are estimated at the sample mean.

Table 8. – Logit Model with the Hourly Wage as a Dependent Variable

	(1) Coefficient	(2) Marginal effect
(Year – 2006)	0.523***	0.027
	(0.051)	(0.002)
$(Year - 2006)^2$	-0.068***	
	(0.008)	
Female	0.507***	0.121
	(0.019)	(0.005)
Unemployment	-0.436***	-0.104
Rate	(0.079)	(0.019)
Constant	0.737***	
	(0.219)	
Observations	46,793	

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The estimated marginal effect of the Time variable is positive and the predicted probability of using this result shows that the match quality between education and occupation for 4 year college graduates has been aggravated over time. Therefore, our analysis on the job-match quality over time is not sensitive to which earning measure is utilized.

Earlier in section 3, it was discussed that part time workers are more likely to report their wage in daily and hourly terms than full time workers. Therefore, the converted monthly wage of part time workers are more dependent on the hours worked than the one of full time workers. In order to check if a certain earning measure drives our result of the logit model on full time and part time workers, the same analysis is carried out using the hourly wage. The logit model is run for part time workers and full time workers separately. The result is presented in Table 9. The marginal effect of the Time term is estimated to be much larger for part time workers than for full time workers, which is consistent with the result from Table 7.

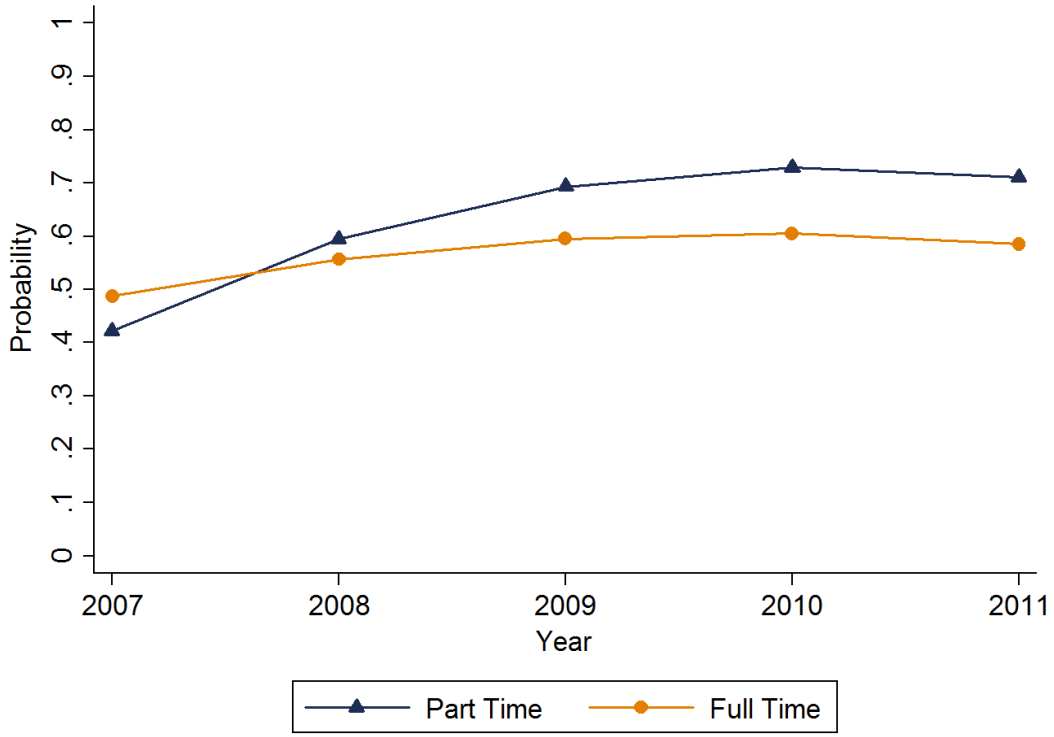
Table 9. – Logit Model for Part time/Full time Workers using the Hourly Wage

	Part time workers only		Full time workers only	
	(1) Coefficient	(2) Marignal effect	(3) Coefficient	(4) Marginal effect
(Year – 2006)	1.091***	0.083	0.460***	0.023
	(0.184)	(0.009)	(0.053)	(0.002)
$(Year - 2006)^2$	-0.131***		-0.060***	
	(0.028)		(0.008)	
Female	-0.557***	-0.123	0.575***	0.138
	(0.079)	(0.018)	(0.020)	(0.005)
Unemployment Rate	-1.407***	-0.310	-0.338***	-0.081
	(0.315)	(0.066)	(0.082)	(0.020)
Constant	3.771***		0.470**	
	(0.902)		(0.227)	
Observations	2,926		43,849	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The predicted probabilities of both part time and full time workers being employed in 2-3 year college jobs are reported in Figure 8 using the result from Table 9. While the predicted probabilities show different shapes than the one from Figure 6, part time workers are still estimated to be more likely to be mismatched over time than full time workers. Therefore, the match quality of job and education for 4 year college graduates working part time is aggravated more than the one of 4 year college graduates working full time, regardless of which earning measure is used in the analysis.

Figure 8. – Estimated Probability by Type of Work using the Hourly wage



5 Discussion

5.1 Decreasing 4 year college premium

The analysis is based on the downward trend in 4 year college premium, which implies that the relative return of 4 year college education compared to 2-3 year college education has been decreasing over time. The narrowing gap between returns of 4 year college education and of 2-3 year college education can be explained in the light of oversupply of 4 year college graduates. Since 2000, the number of 2-3 year colleges has been in decline, whereas the number of 4 year colleges has been increasing. Oh (2014) points out that the increase in the number of 4 year college has taken place outside of Seoul due to the government's policy to control the growth in the metropolitan area. These newly established 4 year colleges outside of Seoul are evaluated as less competitive than the existing 4 year colleges inside Seoul (Oh, 2014). Due to the wide gap among 4 year colleges, most of the 4 year college premium is limited to the top ranked colleges, where most of them are located in Seoul (Chae & Oh, 2014).

The results from the log wage regression in Table 1 supports this claim. The coefficient of Seoul is estimated to be significantly positive and even higher than the coefficient of 4 year college education, every year. This confirms that graduating from 4 year college does not guarantee high returns in the labor market. A more important factor is which 4 year college that a worker graduated from. Classifying the competitiveness of colleges only by the location cannot be the most appropriate way. However, the GOMS data do not contain any further information about the name or rank of the colleges that the respondents graduated from. A more comprehensive analysis can be carried out with more specific information about colleges.

Decreasing 4 year college premium can also result from the economic recession in South Korea after the worldwide financial crisis in 2008. According to the data by the Statistics Korea, the economic growth rate in South Korea recorded 3.9% in 2005 and showed modest upward trend until 2007 by recording 5.5% in 2007. After the financial crisis in 2008, the economic growth rate plunged to 0.7% in 2009.

Previous studies show that graduating college in the economic recession has large, negative, and persistent effect on college graduates' wage (Oreopoulos et al. 2006, Kahn 2010). Furthermore, economic growth driven by technological progress is expected to induce high demand for skilled workers, such as 4 year college graduates in the labor market (Chae & Oh, 2014). Therefore, weakened demand for high skilled workers during the economic recession can lead to reduction in premium that is paid to the skilled workers.

5.2 Gender Issue

The result of log monthly earning regression in Table 1 shows female college graduates are paid less than male college graduates. The logit analyses in section 4 shows that female 4 year college graduates are estimated to be more mismatched than male 4 year college graduates over time. In this section, the labor market outcome of female college graduates is discussed in more detail.

In order to explore the effect of 4 year college education for female workers, an interaction term of the 4 year college education and the female variables is included in the original log monthly wage regression. The interaction term equals to 1 when the respondent is female 4 year college graduate and 0 otherwise. The result of the log wage regression excluding a dummy variable for students from the medical sciences is reported in Table 10.

Table 10. – Log Wage Regression with an Interaction Term

	(1) 2005	(2) 2007	(3) 2008	(4) 2009	(5) 2010	(6) 2011	(7) 2012
4 year college education	0.087*** (0.008)	0.090*** (0.010)	0.065*** (0.011)	0.086*** (0.011)	0.015 (0.012)	0.049*** (0.012)	-0.005 (0.014)
Female	-0.176*** (0.011)	-0.203*** (0.014)	-0.173*** (0.016)	-0.228*** (0.014)	-0.228*** (0.015)	-0.214*** (0.014)	-0.185*** (0.017)
Female × 4 year college education	0.036*** (0.011)	0.043*** (0.015)	0.021 (0.016)	0.054*** (0.015)	0.086*** (0.016)	0.038** (0.016)	0.064*** (0.018)
Age	0.075*** (0.006)	0.057*** (0.007)	0.083*** (0.010)	0.033*** (0.009)	0.067*** (0.008)	0.064*** (0.008)	0.070*** (0.010)
Age^2	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.000** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
Part time	-0.795*** (0.017)	-0.669*** (0.021)	-0.615*** (0.020)	-0.789*** (0.031)	-0.821*** (0.025)	-0.914*** (0.024)	-0.659*** (0.026)
College in Seoul	0.139*** (0.007)	0.134*** (0.009)	0.136*** (0.010)	0.152*** (0.010)	0.149*** (0.010)	0.171*** (0.010)	0.110*** (0.012)
Single	-0.107*** (0.010)	-0.093*** (0.013)	-0.102*** (0.015)	-0.117*** (0.015)	-0.079*** (0.016)	-0.094*** (0.016)	-0.035* (0.020)
GPA	0.029*** (0.004)	0.044*** (0.009)	0.025** (0.010)	0.038*** (0.010)	0.021** (0.010)	0.030*** (0.010)	0.030*** (0.010)
Language	0.105*** (0.009)	0.100*** (0.010)	0.106*** (0.010)	0.097*** (0.010)	0.123*** (0.010)	0.114*** (0.010)	0.097*** (0.013)

Certificate	0.004	0.023***	0.044***	-0.013	0.055***	0.015*	0.037***
	(0.006)	(0.008)	(0.009)	(0.008)	(0.010)	(0.009)	(0.009)
Dad no college	-0.000	-0.010	-0.011	-0.037***	-0.019*	-0.028***	-0.018
	(0.008)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.012)
Mom no college	-0.030**	-0.029**	-0.015	-0.018	0.027*	0.016	0.002
	(0.012)	(0.013)	(0.014)	(0.014)	(0.014)	(0.013)	(0.016)
Family income	0.061***	0.053***	0.017***	0.017***	0.017***	0.012***	0.022***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
City	-0.021***	0.003	0.013*	-0.004	-0.035***	0.008	-0.000
	(0.006)	(0.007)	(0.008)	(0.007)	(0.008)	(0.008)	(0.009)
Humanities	-0.238***	-0.236***	-0.241***	-0.255***	-0.268***	-0.246***	-0.219***
	(0.014)	(0.016)	(0.019)	(0.018)	(0.019)	(0.018)	(0.020)
Social sciences	-0.138***	-0.156***	-0.147***	-0.165***	-0.173***	-0.154***	-0.116***
	(0.011)	(0.014)	(0.016)	(0.014)	(0.014)	(0.014)	(0.016)
Education	-0.156***	-0.213***	-0.221***	-0.191***	-0.189***	-0.225***	-0.176***
	(0.015)	(0.018)	(0.020)	(0.018)	(0.019)	(0.019)	(0.023)
Engineering	-0.098***	-0.100***	-0.097***	-0.106***	-0.123***	-0.119***	-0.079***
	(0.011)	(0.013)	(0.015)	(0.014)	(0.015)	(0.015)	(0.017)
Natural sciences	-0.190***	-0.192***	-0.195***	-0.187***	-0.228***	-0.219***	-0.201***
	(0.013)	(0.016)	(0.017)	(0.016)	(0.017)	(0.018)	(0.020)
Arts, music, and physical education	-0.218***	-0.263***	-0.319***	-0.297***	-0.290***	-0.299***	-0.276***
	(0.014)	(0.016)	(0.018)	(0.017)	(0.018)	(0.018)	(0.019)
Constant	3.576***	3.959***	3.686***	4.594***	4.040***	4.178***	3.940***
	(0.099)	(0.120)	(0.169)	(0.156)	(0.144)	(0.135)	(0.174)
Observations	20,318	13,068	13,195	11,383	13,238	13,560	10,370
R-squared	0.434	0.375	0.299	0.308	0.290	0.316	0.263

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The coefficient of the interaction term is estimated to be significant and positive in most of the years, which indicates that 4 year college education has a positive effect on log monthly earning of female workers. The coefficient of female is estimated to have a significantly negative effect on log monthly earning. Furthermore, the coefficient of the female dummy variable is estimated to be so large that female 4 year college graduates are estimated to be paid less than male 2-3 year college graduates in every year if all other variables are the same. Therefore, female college graduates are paid less than male college graduates regardless of which college they graduated from.

The logit analyses in section 4 show that the marginal effect of the female dummy variable is estimated to be positive, indicating female 4 year college graduates are more likely to be employed in 2-3 year college jobs than male counterparts. In order to compare the match quality of female 4 year college graduates to the one of male 4 year college graduates, the logit model for female and male 4 year college graduates is analyzed separately. The result is reported in Table 11 and the marginal effects are estimated at the sample mean.

Table 11. – Logit Model by Gender

	Male only		Female Only	
	(1) Coefficient	(2) Marginal effect	(3) Coefficient	(4) Marginal effect
(Year – 2006)	0.386***	0.041	0.175**	0.067
	(0.066)	(0.002)	(0.081)	(0.005)
$(Year – 2006)^2$	-0.036***		0.027**	
	(0.011)		(0.011)	
Male Unemployment	-0.191**	-0.046		
Rate	(0.087)	(0.021)		
Female Unemployment			-1.606***	-0.316
Rate			(0.134)	(0.025)
Part time	1.088***	0.262	0.482***	0.095
	(0.076)	(0.018)	(0.069)	(0.013)
Seoul	-0.096***	-0.023	-0.307***	-0.060
	(0.031)	(0.008)	(0.037)	(0.007)
Humanities	1.888***	0.455	2.107***	0.415
	(0.085)	(0.021)	(0.075)	(0.016)
Social sciences	1.870***	0.451	2.581***	0.508
	(0.076)	(0.018)	(0.075)	(0.016)
Education	1.985***	0.479	2.211***	0.435
	(0.100)	(0.024)	(0.086)	(0.018)
Engineering	0.242***	0.058	0.958***	0.189
	(0.074)	(0.018)	(0.077)	(0.016)
Natural sciences	1.500***	0.362	1.913***	0.377
	(0.080)	(0.019)	(0.076)	(0.016)
Arts, music and physical	2.005***	0.483	2.029***	0.400
Education	(0.088)	(0.021)	(0.078)	(0.016)
Constant	-0.914***		3.023***	
	(0.291)		(0.303)	
Observations	27,351		19,424	

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The logit model includes all the control variables from the sensitivity checks. The unemployment rate used in the model is measured separately by gender. While the male unemployment rate has always been higher than the female unemployment rate, the male employment rate has always been higher than the female employment rate during the given period.[8] The employment rate is calculated by dividing the number of population aged more than 15 into the number of people who are working at the time of the measurement. The unemployment rate excludes not economically active population from the calculation, for example discouraged workers who stopped looking for jobs. In South Korea, the number of not economically active population among females has always been higher than males from 2007 to 2011. Therefore, it is possible that a lot of female 4 year college graduates are classified as not economically active population given the labor market results of females. The employment rate of male 4 year college graduates has always been higher than the one of female 4 year college graduates. This also indicates that female 4 year college graduates have a hard time of getting a job than male 4 year college graduates.

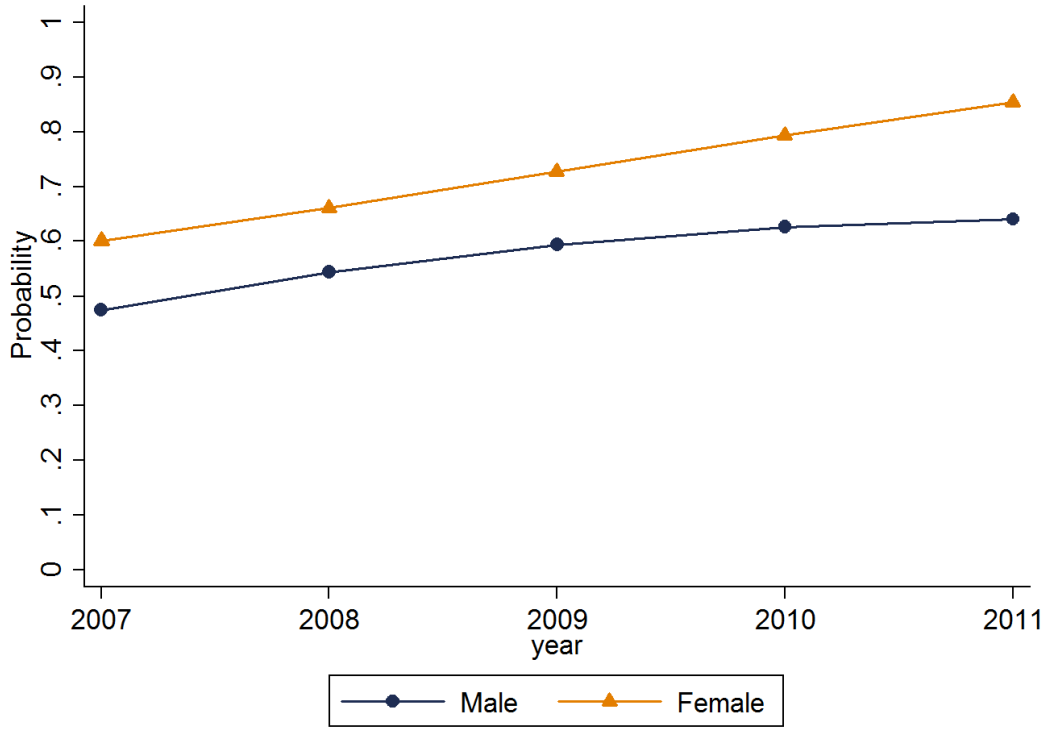
The signs of both unemployment rates are estimated to be negative, which indicates that the 4 year college graduates are less mismatched when the unemployment rate is higher. This result is counter intuitive. However, when the logit model is run with an alternative indicator, the employment rate by gender, or without any indicator for the labor market situation, the marginal effect of the Time variable is estimated to be positive.

The marginal effect of the Time variable shows the same result as the logit models in section 4, which shows that 4 year college graduates are more likely to be employed in 2-3 year college jobs over time. The estimated marginal effect of the Time term is larger for female than for male. In Figure 9, the probability of a 4 year college graduate hired in a 2-3 year college job is predicted separately by gender. The probabilities are estimated using marginal effects of variables at the sample mean. Figure 9 shows that the probability of female 4 year college graduates employed in 2-3 year college job is predicted to be higher than male 4 year college graduates. When the logit model for female and male 4 year college graduates is

[8] The statistics from 2007 to 2011 are as follows. While the male unemployment rate recorded 3.7%, 3.6%, 4.1%, 4.0%, and 3.6%, the female unemployment rate recorded 2.6%, 2.6%, 3.0%, 3.3%, and 3.1%. The male employment rate recorded 71.3%, 70.9%, 70.1%, 70.1% and 70.5% and the female unemployment rate recorded 48.9%, 48.7%, 47.7%, 47.8%, and 48.1%, respectively (Statistics Korea 2014b, 2015).

analyzed separately by using the hourly wage instead of the monthly wage, the results are found to be very similar to Table 11 and Figure 9.

Figure 9. – Probability of a 4 Year College Graduate in a 2-3 Year College Job by Gender



According to the paper by the Statistics Korea and the Ministry of Gender Equality and Family (2014), the female college entrance rate has been higher than the male college entrance rate since 2009 and the gap has been widening. In 2013, the college entrance rate of females recorded 74.5% while the male college entrance rate recorded 67.4%. Our analyses show that female college graduates are not only paid less than male counterparts regardless of the level of education, but the female 4 year college graduate are more likely to experience the mismatch between job and education than the male counterparts. This might be partly due to the fact that working as a part time worker is more prevalent for female 4 year college graduates than male 4 year college graduates. The proportion of part time workers among female 4 year college graduates and male college graduates in our sample is 8.5% and 4.7%, respectively.

An interaction term between the female and the part time variables is included in addition to the interaction term between the 4 year college education and the female variables in the

original regression to see the relationship between female and part time. The regression result is reported in Appendix Table 5. The coefficient of the interaction term between the female and the part time variables shows mixed results in every year. In most of the years, the coefficient of the interaction term is estimated to be statistically insignificant. The estimated coefficient of other variables is very similar to the results from Table 1 and Table 10. The female variable and the part time variable are estimated to have significantly negative effects on log monthly earning.

5.3 Limitations

While the GOMS data offer comprehensive information about college graduates in South Korea, the currently available data are for the graduates from 2005 to 2012, excluding the graduates from year 2006. Therefore, our analyses lacks the data from a long time period. Since the economic recession in South Korea after 2008 might drive our result, using data from other time periods could make it possible to verify the relationship between the economic situation and the 4 year college premium.

The Gottschalk and Hansen model compares college graduates to noncollege graduates. Our model applies this framework directly to compare 4 year college graduates to 2-3 year college graduates. However, a more appropriate approach would be possible by using the data of noncollege workers and dividing college workers into two different groups, 4 year college graduates and 2-3 year college graduates. There are two survey data from the Korean Employment Information Service that can be utilized. The High School Graduates Employment Survey is conducted every other year on the sample of high school graduates to explore their labor market outcome from 2010. The Youth Panel is a longitudinal survey on a sample of Korean youth (from 15 to 29 years old). The first survey was conducted in 2001 and follow-up surveys on the sample was conducted annually from 2001 to 2006 (YP2001). The second Youth Panel was launched in 2007 (YP2007) to a different sample of Korean youth and follow up surveys have been conducted.

From the logit analyses, the overall unemployment rate is identified as not a good indicator of the labor market situation for our sample. The most appropriate indicator would be the employment rate of 4 year college graduates produced by the Statistics Korea and the Korean Educational Development Institute. The employment rate is the ratio of health insurance subscribers by employment to the college graduates who are eligible to work. However, this measurement method was newly introduced in 2010, so the statistics before and after 2010 cannot be comparable. Therefore, the existing data of employment rate of 4 year college graduates do not cover the period of our analysis.

6 Conclusions

This paper explores how 4 year college education affects job-match quality compared to 2-3 year college education in South Korea by applying the framework by Gottschalk and Hansen (2003). Our result from log monthly wage regression shows that there is a downward trend in 4 year college premium from 2007 to 2011, which indicates that the relative advantage of 4 year college education compared to 2-3 year college education has been decreasing over time. This finding corresponds to the current unemployment crisis for 4 year college graduates in South Korea, where the number of 4 year college graduates who choose to reenter 2-3 year colleges has been increasing. The narrowing gap between returns of 4 year college education and of 2-3 year college education is addressed in the light of supply and demand in the labor market. Due to the increasing number of 4 year colleges compared to 2-3 year colleges, there has been an oversupply of 4 year college graduates in the labor market. In the meantime, the demand for high skilled workers, such as 4 year college graduates, has been weakened during the economic recession in South Korea after the worldwide financial crisis in 2008.

The Gottschalk and Hansen model predicts that a decrease in 4 year college premium would result in aggravated match quality between job and education over time. Our analysis using the logit model shows that the probability of 4 year college graduates hired in 2-3 year college jobs is estimated to be increasing over time, which is consistent with the model. The analysis is found to be robust to sensitivity checks. However, there exist limitations in the analysis due to the lack of data from long time periods and a suitable indicator of the labor market situation for our sample. Furthermore a more appropriate approach to the Gottschalk and Hansen model would be possible using data for noncollege workers. From the further analysis regarding labor market outcome of subgroups, it is shown that female college graduates and college graduates working part time are not only paid less than their counterparts, male and full time workers, but are more likely to experience the mismatch between job and education than their counterparts.

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Appendix

Table 1. - The List of Occupations and the Three-Digit Code from the KECO 2007

Name of Occupation	**KECO 2007**
Managers in business support and administration, social services, sales and transports, and culture sector	11, 12, 13, 14, 17
Managers in construction, production, information, data, food, tourism, and cleaning and security	15, 16, 18, 19
Insurance sales related workers and professionals in business support and administration, accounting, finance, advertising, public relation, and research	21, 22, 23, 31
Business support and administration related clerks	24
Products production related clerks	25
Trade and transportation related clerks	26
Accounting related clerks	27
Reception clerks, customer consultants, and statistics survey related clerks	28
Secretaries and assistant clerks	29
Insurance related clerks and financial clerks	32
Insurance related salesperson	33
Professors, teaching assistants, education related professionals, and teachers	41, 42, 46

Professionals in natural sciences, social sciences and liberal arts, and researchers in natural sciences and science technician	43, 44, 45
Kindergarten teachers	47
Visiting teachers and instructors	48
Legal professionals and legal assistants	51, 52
Police, fire fight, and prison related workers	53
Doctors, veterinarians, pharmacists, and medical and welfare service related workers	61, 62, 63, 68
Nurses and dental hygienists	64
Therapists	65
Medical equipment and dental related technicians	66
Health and medical related workers	67
Social welfare specialists, consultants, and religion related workers	71, 73
Child care teachers, infant rearing helpers, and other social welfare related workers	72
Writers, publishing professionals, journalist, curators, librarians, archivists, and other culture and art related workers	81, 82, 83, 88
Painters, photographers, and performing artists	84
Designers, fiber and textile related engineers, researchers, technicians, textile producing machine operator, tailor, and other textile related workers	85, 181-186
Drama, film and movie image professionals	86
Drama, film and movie image related engineers	87

Aircraft pilots, ship engineers, controllers, and handling equipment operators	91, 94
Locomotive drivers, train related workers, deliverers, and transport related elementary occupations	92, 95
Automobile drivers	93
Sales and brokerage related workers	101
Real estate agents, store salespersons, and street salespersons and vendors	102, 105
Retail salespersons and telecommunication sales related workers	103
Cashiers and ticket agents	104
Security related workers	111
Cleaning persons, domestic chores helpers, laundry and ironing workers, meter reading, and money collecting and parking controlling related workers	112, 113, 114, 115
Hairdressing related service workers, wedding ceremony and funeral service workers, and lodging service workers	121, 122, 124, 125
Travel related service workers	123
Entertainment facility related workers	126
Sports and recreation related service workers	127
Cooks	131
Food service occupations	132
Construction related professionals and engineers	141

Construction structure related workers, plumbers, construction and mining machines operators, and construction and mining elementary workers	142, 143, 144, 145, 146, 147
Mechanical, electrical, and electronic related engineers and researchers	151
Machinery equipment fitters and mechanics	152
Transport equipment mechanics and automobile mechanics	153, 154
Die and mold making machine operators, automobile and machine parts assemblers, and other machine related operator	155, 156, 157, 158, 159
Metal and material engineers, researchers, and technicians, pipe and sheet metal makers, forging press workers, welders, and metal and non-metal processing related control equipment operators	161, 162, 163, 164, 165, 166, 167
Chemical engineer, researchers and technicians, petroleum and other chemical materials processing machine operators, and chemical, rubber and plastic production machine operators	171, 172, 173
Electrical and electronic engineers and researchers	191
Electricians and power generation and distribution equipment operators	192, 194
Electric and electronic machine fitters and repairers	193
Electrical and electronic equipment operators	195
Electrical, electronic parts and product producing equipment operators and electrical, electronic parts and products assemblers	196, 197
Computer hardware and telecommunication engineering researchers and computer system designers	201, 202

Software developers	203
Web developers and web and multimedia directors	204
Database developers and information system administrators	205
Telecommunication and broadcast transmission equipment technicians and repairers	206
Food engineers, researchers, technicians, and food processing machine related operator, bakers, cookie makers, and food processing related workers	211, 212, 213, 214
Environmental engineer, researchers, and technicians	221
Industrial safety and energy related engineers, researchers, and technicians	222
Water treatment and recycling related operating occupations, print and photo development related machine operators, wood and paper pulp processing plant operators, furniture assemblers, handcraft workers, signboard makers, other producing plant operators, and production related elementary workers	223, 224, 225, 226, 227, 228, 229
Crop growers and agricultural, forestry, fishery related occupations	231, 232, 233, 234, 235
Armed forces	240

Table 2. - Control Variables

Variable Name	Explanation
Age	The age of the respondent is used in linear and quadratic forms.
Female	Dummy variable equals to one when the respondent is female, zero when male.
Part time	Dummy variable equals to one when the respondent's current job is part time job, zero when it is full time job. Part time job is explained as "a temporary job to earn money" in the survey questionnaire from 2008.
Single	Dummy variable equals to one when the respondent is single, separated, divorced, or widowed, zero when married.
GPA	Respondent's average grade from the college.
Language	Dummy variable equals to one when the respondent has been abroad for the purpose of language training, zero otherwise.
Certificate	Dummy variable equals to one when the respondent has certificate(s), zero otherwise.
Dad no college	Dummy variable equals to one when the respondent's father does not have 4 year college degree or graduate degree, equals zero otherwise.
Mom no college	Dummy variable equals to one when the respondent's mother does not have 4 year college degree or graduate degree, equals zero otherwise.
College in Seoul	Dummy variable equals to one when the respondent graduated from the college located in Seoul, zero otherwise.
City	Dummy variable equals to one when the respondent currently lives in the city, zero otherwise.

Family income	The level of current family monthly income. Equals to one when the income is below one million KRW, equals to two when more than one million and less than two million KRW, equals to three when more than two million less than three million KRW, equals to four when more than three million less than four million KRW, equals to five when more than four million and less than five million KRW, equals to six when more than five million and less than seven million KRW, equals to seven when more than seven million and less than ten million KRW, equals to eight when more than ten million KRW.
Humanities	Dummy variable equals to one when the respondent majored in the humanities, zero otherwise.
Social sciences	Dummy variable equals to one when the respondent majored in social sciences, zero otherwise.
Education	Dummy variable equals to one when the respondent majored in education, zero otherwise.
Engineering	Dummy variable equals to one when the respondent majored in engineering, zero otherwise.
Natural sciences	Dummy variable equals to one when the respondent majored in natural sciences, zero otherwise.
Arts, music, and physical education	Dummy variable equals to one when the respondent majored in arts, music and physical education, zero otherwise.
Medical studies	Dummy variable equals to one when the respondent majored in medical science, zero otherwise (excluded).
T-1, T+1	Dummy variables for indicating years that are pooled to attain sufficient sample size. In case of 2007, the sample from 2005, 2007, and 2008 are pooled due to the discontinuation of the survey in 2006 and T-2 is used instead of T-1.

Table 3. – Log Hourly Wage Regression by Year

	(1) 2005	(2) 2007	(3) 2008	(4) 2009	(5) 2010	(6) 2011	(7) 2012
4 year college education	0.185*** (0.008)	0.164*** (0.011)	0.128*** (0.011)	0.152*** (0.010)	0.115*** (0.011)	0.114*** (0.011)	0.103*** (0.012)
Female	-0.050*** (0.010)	-0.098*** (0.012)	-0.042*** (0.011)	-0.120*** (0.011)	-0.077*** (0.012)	-0.113*** (0.011)	-0.056*** (0.013)
Age	0.082*** (0.008)	0.052*** (0.011)	0.093*** (0.009)	0.048*** (0.009)	0.070*** (0.009)	0.070*** (0.008)	0.078*** (0.011)
Age^2	-0.001*** (0.000)	-0.000*** (0.000)	-0.001*** (0.000)	-0.000*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
Part time	-0.057** (0.024)	0.041 (0.032)	-0.204*** (0.023)	-0.290*** (0.036)	-0.254*** (0.030)	-0.422*** (0.031)	-0.284*** (0.025)
College in Seoul	0.174*** (0.009)	0.138*** (0.011)	0.158*** (0.011)	0.155*** (0.010)	0.163*** (0.011)	0.178*** (0.011)	0.140*** (0.013)
Single	-0.136*** (0.013)	-0.101*** (0.016)	-0.087*** (0.016)	-0.126*** (0.016)	-0.079*** (0.018)	-0.097*** (0.017)	-0.102*** (0.022)
GPA	0.042*** (0.005)	0.064*** (0.012)	0.043*** (0.011)	0.055*** (0.010)	0.035*** (0.011)	0.050*** (0.011)	0.076*** (0.012)
Language	0.090*** (0.012)	0.097*** (0.012)	0.097*** (0.011)	0.092*** (0.011)	0.097*** (0.012)	0.087*** (0.011)	0.072*** (0.014)
Certificate	-0.011 (0.008)	0.010 (0.010)	0.030*** (0.010)	-0.027*** (0.009)	0.026** (0.011)	0.009 (0.010)	0.003 (0.010)
Dad no college	-0.015 (0.011)	-0.005 (0.013)	-0.031*** (0.012)	-0.046*** (0.011)	-0.028** (0.012)	-0.038*** (0.012)	-0.039*** (0.013)
Mom no college	-0.033** (0.015)	-0.024 (0.017)	-0.014 (0.016)	-0.005 (0.014)	-0.023 (0.016)	0.015 (0.014)	0.021 (0.017)
Family income	0.058*** (0.003)	0.054*** (0.003)	0.015*** (0.003)	0.017*** (0.003)	0.020*** (0.003)	0.014*** (0.003)	0.019*** (0.003)
City	-0.025*** (0.007)	-0.001 (0.009)	0.012 (0.009)	-0.012 (0.008)	-0.038*** (0.009)	-0.006 (0.008)	0.001 (0.010)
Humanities	-0.145*** (0.018)	-0.151*** (0.021)	-0.153*** (0.021)	-0.164*** (0.018)	-0.205*** (0.021)	-0.152*** (0.020)	-0.151*** (0.021)
Social sciences	-0.095*** (0.014)	-0.104*** (0.019)	-0.121*** (0.018)	-0.134*** (0.015)	-0.173*** (0.016)	-0.123*** (0.016)	-0.101*** (0.018)
Education	-0.095*** (0.019)	-0.126*** (0.024)	-0.110*** (0.024)	-0.143*** (0.020)	-0.126*** (0.023)	-0.098*** (0.021)	-0.052** (0.024)

Engineering	-0.050***	-0.057***	-0.099***	-0.086***	-0.139***	-0.107***	-0.059***
	(0.014)	(0.018)	(0.018)	(0.015)	(0.017)	(0.017)	(0.019)
Natural sciences	-0.142***	-0.129***	-0.173***	-0.155***	-0.239***	-0.193***	-0.188***
	(0.017)	(0.021)	(0.020)	(0.017)	(0.020)	(0.020)	(0.022)
Arts, music, and physical education	-0.133***	-0.181***	-0.179***	-0.205***	-0.215***	-0.181***	-0.157***
	(0.018)	(0.023)	(0.021)	(0.019)	(0.021)	(0.021)	(0.023)
Constant	0.261**	0.803***	0.278*	1.197***	0.876***	0.891***	0.657***
	(0.130)	(0.182)	(0.167)	(0.160)	(0.161)	(0.151)	(0.187)
Observations	18,828	12,200	13,192	11,354	13,237	13,556	10,323
R-squared	0.216	0.151	0.141	0.192	0.127	0.158	0.131

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The difference in sample sizes between log monthly wage regression and log hourly wage regression comes from the missing values in the number of hour worked from the data set.

Table 4. – 4 Year College Premium, Percentage of 4 Year College Graduates, Average Monthly Wage, Average Monthly Wage for 4 Year College Graduates: KECO 2007-2011

	2007				2011			
	4 year college premium	Percentage of total 4 year college graduates	Average monthly wage for 4 year college graduates (10, 000 KRW)	Average monthly wage (10,000 KRW)	4 year college premium	Percentage of total 4 year college graduates	Average monthly wage for 4 year college graduates (10, 000 KRW)	Average monthly wage (10,000 KRW)
Food service occupations	-0.13	0.3	110	114	-0.17	0.4	121	120
Painters, photographers, and performing artists	-0.13	0.7	125	128	-0.14	0.6	156	155
Professionals in natural sciences, social sciences and liberal arts, and researchers in natural sciences and science technician [a]4	-0.09	1.3	150	152	-0.12	1.4	174	175
Metal and material engineers, researchers, and technicians, pipe and sheet metal makers, forging press workers, welders, and metal and non-metal processing related control equipment operators [a]	-0.08	0.5	207	201	-0.03	0.5	243	239
Drama, film and movie image related engineers	-0.08	0.4	150	150	0.02	0.3	142	147
Construction structure related workers, plumbers, construction and mining machines operators, and construction and mining elementary workers [a]	-0.06	0.2	189	192	0.02	0.2	192	210

Water treatment and recycling related operating occupations, print and photo development related machine operators, wood and paper pulp processing plant operators, furniture assemblers, handcraft workers, signboard makers, other producing plant operators, and production related elementary workers [a]	-0.05	0.3	160	151	-0.08	0.4	159	164
Retail salespersons and telecommunication sales related workers	-0.05	1.5	170	167	0	1.7	197	186
Cashiers and ticket agents	-0.04	0.3	187	182	0.04	0.3	155	158
Automobile drivers	-0.03	0.3	173	166	-0.13	0.2	169	187
Therapists	-0.02	0.7	164	169	-0.02	1.0	169	177
Secretaries and assistant clerks	-0.01	2.8	121	118	-0.06*	3.2	127	128
Environmental engineer, researchers, and technicians	-0.01	0.7	174	177	0.03	0.6	202	198
Armed forces	0	0.6	180	194	0.04	0.8	186	194
Social welfare specialists, consultants, and religion related workers [a]	0	3.0	127	133	0.06*	3.4	149	149
Child care teachers, infant rearing helpers, and other social welfare related workers	0.01	0.9	122	119	0.09**	0.8	149	138
Business support and administration related clerks	0.01	14.0	196	199	0.03	14.5	220	219
Chemical engineer, researchers and technicians, petroleum and other chemical materials processing machine operators, and chemical, rubber and plastic production machine operators [a]	0.01	1.0	221	214	0.03	1.0	248	248
Police, fire fight, and prison related workers	0.01	0.6	241	262	-0.01	0.6	267	274

Cleaning persons, domestic chores helpers, laundry and ironing workers, meter reading, and money collecting and parking controlling related workers [a]	0.03	0.2	149	147	-0.06	0.2	166	165
Security related workers	0.03	0.2	159	157	-0.01	0.3	171	167
Insurance related clerks and financial clerks	0.04	3.2	253	250	0	3.1	260	259
Accounting related clerks	0.05**	3.2	182	165	0.09***	3.4	205	188
Reception clerks, customer consultants, and statistics survey related clerks	0.05	1.7	145	139	0.05	1.6	150	147
Die and mold making machine operators, automobile and machine parts assemblers, and other machine related operator [a]	0.05	0.3	200	187	0.02	0.4	220	223
Food engineers, researchers, technicians, and food processing machine related operator, bakers, cookie makers, and food processing related workers [a]	0.06	0.3	181	172	0.03	0.4	193	195
Web developers and web and multimedia directors	0.06	0.7	186	181	0.13**	0.7	227	219
Writers, publishing professionals, journalist, curators, librarians, archivists, and other culture and art related workers [a]	0.07	1.9	164	162	0.12*	1.7	185	180
Telecommunication and broadcast transmission equipment technicians and repairers	0.07	0.3	197	189	0.07	0.1	206	187
Insurance related salesperson	0.07	0.8	313	312	-0.03	0.7	304	304
Sports and recreation related service workers	0.08	1.0	184	175	-0.02	1.0	200	201
Hairdressing related service workers, wedding ceremony and funeral service workers, and lodging service workers [a]	0.08	0.3	201	168	0.09	0.4	187	165
Visiting teachers and instructors	0.08**	8.0	134	133	0.09*	6.3	152	149

Trade and transportation related clerks	0.08**	1.4	200	191	0.17***	1.2	236	229
Legal professionals and legal assistants [a]	0.09	0.5	228	218	0.12	0.5	283	275
Electrical, electronic parts and product producing equipment operators and electrical, electronic parts and products assemblers [a]	0.09	0.2	205	180	-0.02	0.3	220	210
Machinery equipment fitters and mechanics	0.09**	0.4	235	217	0.02	0.5	258	254
Computer hardware and telecommunication engineering researchers and computer system designers [a]	0.09*	0.9	234	229	0.18*	0.9	267	260
Health and medical related workers	0.10*	0.6	159	155	0.19***	0.8	182	177
Cooks	0.11	0.3	189	163	0.04	0.7	180	172
Drama, film and movie image professionals	0.11	0.6	171	159	-0.04	0.5	170	166
Designers, fiber and textile related engineers, researchers, technicians, textile producing machine operator, tailor, and other textile related workers [a]	0.12***	3.5	166	154	0.07**	3.3	181	172
Crop growers and agricultural, forestry, fishery related occupations [a]	0.12	0.2	313	300	-0.16	0.3	197	275
Industrial safety and energy related engineers, researchers, and technicians	0.12**	0.6	256	219	0.22***	0.5	254	240
Electrical and electronic engineers and researchers	0.12***	2.7	238	229	0.17***	2.8	282	271
Managers in business support and administration, social services, sales and transports, and culture sector [a]	0.13	0.2	357	387	-0.02	0.2	438	497
Electric and electronic machine fitters and repairers	0.13**	0.4	185	167	-0.04	0.4	192	190
Products production related clerks	0.14***	4.8	220	206	0.14***	5.2	250	238
Construction related professionals and engineers	0.14***	4.4	213	206	0.12***	2.7	234	233

Travel related service workers	0.15*	0.3	157	143	0.04	0.3	168	158
Software developers	0.15***	3.0	219	212	0.17***	2.4	255	246
Mechanical, electrical, and electronic related engineers and researchers	0.15***	2.5	250	239	0.28***	2.3	293	277
Professors, teaching assistants, education related professionals, and teachers [a4]	0.15*	5.7	159	159	-0.30***	7.1	141	141
Sales and brokerage related workers	0.15***	5.0	227	221	0.11***	4.6	259	255
Insurance sales related workers and professionals in business support and administration, accounting, finance, advertising, public relation, and research [a]	0.17***	2.9	272	268	0.06	3.6	278	276
Electrical and electronic equipment operators	0.18***	0.2	219	201	0.20*	0.1	238	234
Database developers and information system administrators	0.18***	1.9	203	191	0.17***	1.8	234	218
Locomotive drivers, train related workers, deliverers, and transport related elementary occupations [a]	0.18*	0.2	178	182	0.16	0.2	180	177
Managers in construction, production, information, data, food, tourism, and cleaning and security [a]	0.18	0.2	375	362	0.22	0.1	462	490
Medical equipment and dental related technicians	0.18***	0.3	230	166	0.24***	0.3	217	181
Real estate agents, store salespersons, and street salespersons and vendors [a]	0.20*	0.3	203	171	-0.13	0.4	149	157
Transport equipment mechanics and automobile mechanics [a]	0.21**	0.2	220	199	0.17	0.1	213	204
Electricians and power generation and distribution equipment operators [a]	0.23***	0.3	261	231	0	0.2	241	235
Nurses and dental hygienists	0.23***	0.9	228	188	0.19***	1.2	253	219

Doctors, veterinarians, pharmacists, and medical and welfare service related workers [a]	0.24***	2.3	253	223	0.38***	1.8	301	253
Entertainment facility related workers	0.26	0.2	189	164	-0.03	0.1	178	151
Kindergarten teachers	0.27***	0.2	156	129	0.04	0.4	174	169
Aircraft pilots, ship engineers, controllers, and handling equipment operators [a]	0.35***	0.2	289	234	0.29**	0.2	328	282

[a] indicates that an occupational category is aggregated above the original three-digit category

[4] indicates that an occupation is classified as 4 year college job because the proportion of the 4 year college graduates among total employees in the occupation is over 90%. Only two occupations in 2011 are classified as 4 year college job based on this standard. One is the occupation including professors, teaching assistants, education related professionals, and teachers. The other is the occupation including professionals in natural sciences, social sciences and liberal arts, and researchers in natural sciences and science technician

*, **, *** indicates significance at the 10%, 5%, and 1% level respectively

Table 5. – Log Monthly Wage Regression with Interaction Terms

	(1) 2005	(2) 2007	(3) 2008	(4) 2009	(5) 2010	(6) 2011	(7) 2012
4 year college education	0.087*** (0.008)	0.090*** (0.010)	0.066*** (0.011)	0.086*** (0.011)	0.015 (0.012)	0.049*** (0.012)	-0.005 (0.014)
Female	-0.179*** (0.011)	-0.213*** (0.014)	-0.166*** (0.016)	-0.233*** (0.014)	-0.229*** (0.015)	-0.216*** (0.014)	-0.193*** (0.017)
Female × 4 year college education	0.034*** (0.011)	0.040*** (0.015)	0.021 (0.016)	0.054*** (0.015)	0.086*** (0.016)	0.038** (0.016)	0.067*** (0.019)
Female × part time	0.052 (0.035)	0.150*** (0.041)	-0.075* (0.039)	0.143** (0.061)	0.028 (0.051)	0.042 (0.048)	0.081 (0.052)
Age	0.074*** (0.006)	0.057*** (0.007)	0.083*** (0.010)	0.033*** (0.009)	0.067*** (0.008)	0.064*** (0.007)	0.070*** (0.010)
Age^2	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.000** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
Part time	-0.826*** (0.027)	-0.755*** (0.030)	-0.580*** (0.028)	-0.874*** (0.044)	-0.838*** (0.040)	-0.938*** (0.036)	-0.705*** (0.040)
Seoul	0.139*** (0.007)	0.135*** (0.009)	0.137*** (0.010)	0.152*** (0.010)	0.149*** (0.010)	0.171*** (0.010)	0.109*** (0.012)
Single	-0.106*** (0.010)	-0.091*** (0.013)	-0.103*** (0.015)	-0.117*** (0.015)	-0.079*** (0.016)	-0.094*** (0.016)	-0.034* (0.020)
GPA	0.029*** (0.004)	0.044*** (0.009)	0.025** (0.010)	0.038*** (0.010)	0.021** (0.010)	0.030*** (0.010)	0.030*** (0.010)
Language	0.105*** (0.009)	0.099*** (0.010)	0.107*** (0.010)	0.096*** (0.010)	0.123*** (0.010)	0.114*** (0.010)	0.096*** (0.013)
Certificate	0.005 (0.006)	0.023*** (0.008)	0.044*** (0.009)	-0.013 (0.008)	0.055*** (0.010)	0.015* (0.009)	0.037*** (0.009)
Dad no college	-0.001 (0.008)	-0.010 (0.010)	-0.012 (0.011)	-0.037*** (0.010)	-0.019* (0.011)	-0.028*** (0.010)	-0.017 (0.012)
Mom no college	-0.029** (0.012)	-0.028** (0.013)	-0.015 (0.014)	-0.018 (0.014)	0.027* (0.014)	0.016 (0.013)	0.001 (0.016)
Family income	0.061*** (0.002)	0.053*** (0.002)	0.017*** (0.003)	0.017*** (0.003)	0.017*** (0.003)	0.012*** (0.003)	0.022*** (0.003)
City	-0.021*** (0.006)	0.004 (0.007)	0.013* (0.008)	-0.003 (0.007)	-0.035*** (0.008)	0.008 (0.008)	0.000 (0.009)
Humanities	-0.238*** (0.014)	-0.235*** (0.016)	-0.241*** (0.019)	-0.255*** (0.018)	-0.269*** (0.019)	-0.247*** (0.018)	-0.221*** (0.020)
Social sciences	-0.138*** (0.011)	-0.158*** (0.014)	-0.147*** (0.016)	-0.165*** (0.014)	-0.173*** (0.014)	-0.155*** (0.014)	-0.117*** (0.016)

Education	-0.156***	-0.212***	-0.220***	-0.190***	-0.189***	-0.226***	-0.177***
	(0.015)	(0.018)	(0.020)	(0.018)	(0.019)	(0.019)	(0.023)
Engineering	-0.098***	-0.103***	-0.096***	-0.108***	-0.123***	-0.120***	-0.081***
	(0.011)	(0.013)	(0.015)	(0.014)	(0.015)	(0.015)	(0.017)
Natural sciences	-0.191***	-0.193***	-0.195***	-0.188***	-0.228***	-0.219***	-0.202***
	(0.013)	(0.016)	(0.017)	(0.016)	(0.017)	(0.018)	(0.020)
Arts, music and physical education	-0.220***	-0.267***	-0.317***	-0.298***	-0.290***	-0.300***	-0.277***
	(0.014)	(0.016)	(0.018)	(0.017)	(0.018)	(0.018)	(0.019)
Constant	3.580***	3.959***	3.683***	4.605***	4.040***	4.178***	3.947***
	(0.100)	(0.120)	(0.169)	(0.156)	(0.144)	(0.135)	(0.174)
Observations	20,318	13,068	13,195	11,383	13,238	13,560	10,370
R-squared	0.434	0.376	0.300	0.309	0.290	0.316	0.263